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Profiles and Biology of Western European Streams as Related to Fish Management [1]

MARCEL HUET

Director, Belgian Waters and Forests Research Station and Lecturer at the University of Louvain

ABSTRACT

In the running waters of temperate Western Europe there are four main biological zones, each of which is characterized by a distinctive fish fauna. These are designated; (1) trout, (2) grayling, (3) barbel, and (4) bream zones. They are related basically to longitudinal section (slope of the stream bed) and to the cross section of the stream and its valley. The physical and biological characteristics of these zones are discussed together with the concepts "slope-rule" and "slope-graph", which express these relationships, and which have proven useful for evaluating and comparing running waters and for estimating fisheries potentials of streams from topographic information.

INTRODUCTION

In Western Europe, as elsewhere in the orld, standing fresh waters, such as lakes, onds, and marshes, have been the subject of any researches; but there has been much less udy of running waters. The present paper eals with the streams of western Europe and, or the most part, summarizes information thered by the author concerning them.

In these streams it has long been recognized at there are four main—and usually quite stinct—biological zones each of which has characteristic fish fauna with a diagnostic or ey" species of fish. Principal emphasis in e present paper is on the relationships beeen the biological zones of the streams and e physical nature of the water course; espeally its cross and longitudinal sections. These lationships have been of great use in fish anagement in Western European streams and ndoubtedly have potential use elsewhere.

FISH FAUNAL ZONES IN STREAMS

The usual sequence of the fish faunal zones om headwaters to mouth of Western European streams is: (1) trout (*Salmo trutta*) zone, (2) grayling (*Thymallus thymallus*) zone, (3) barbel (*Barbus barbus*) zone, and (4) bream (*Abramis brama*) zone. In the two lower zones, which are characterized by cyprinids (Zones 3 and 4), the barbel and associated fishes are most common in those waters with moderate current and flow (Zone 3). The bream and associated smaller cyprinids are usually fishes of quieter waters (Zone 4)—somewhat as is the golden shiner (*Notemigonus chrysoleucas*) in North America.

The zonation evident in the fish fauna is mostly the result of stream gradient which affects both water temperature and rapidity of current. There are, however, many other characteristics of streams which are related to stream gradient and which, directly or indirectly, affect fish: such characteristics as the physical nature of the stream bottom (especially soils), composition of the aquatic flora and abundance of aquatic plants, and the composition and size of the populations of bottom-dwelling invertebrate animals (bottom fauna). The effect of stream gradient and current upon distribution of fish in streams has been noted both in Europe by Leger (1945) and in North America by Trautman (1942).

[1] Address at the 88th Annual Meeting of the merican Fisheries Society at Philadelphia, Septemr 1958.

The four icthyological zones occurring in European streams really represent two faunistic regions: an upper salmonid region of cooler waters (trout and grayling zones) and a lower cyprinid region of warmer waters (barbel and bream zones). However, from the point of view of stream gradient and rapidity of current the trout, grayling, and barbel zones can be grouped, for they are all zones of rapidly flowing waters that are characterized by rheophilic fishes. In contrast, the bream zone is of waters with little or slow movement and the fishes associated with the bream in this lower zone are predominantly limnophilic. Faunistic relationships and the principal species of fish in the four zones are shown in Table 1.

The physical characteristics of the four stream zones are as follows:

Trout Zone

Waters of the trout zone are cool brooks, creeks, and rivers with steep gradient and rapid, sometimes even torrential, flow. The wate is always well oxygenated. Summer water tem peratures rarely exceeds 64°F. The strean bottom is most often rock, boulders, or pebble but is sometimes gravelly or sandy. The wate varies considerably in depth but is often quit shallow. Stream width is also quite variable Along with the brown trout, which dominate the fish population, are the sculpin (*Cottu gobio*) and the minnow (*Phoxinus phoxinus*) The physical characteristics of the trout zon differ somewhat in high mountains, mountain of moderate height, foothills, and coasta plains; but the water is always cool and wel oxygenated. A typical stream of the Trou Zone is shown in Figure 1.

Grayling Zone

The grayling zone is characteristic of river and larger streams (Figure 2) that have rathe rapidly flowing water. Gradient is generall less than in trout waters and the riffles an

TABLE 1.—*Occurence and relative abundance of principal fishes in gradient zones of running waters o temperate western Europe* [Relative abundance of kinds of fishes is indicated by the number of asterisks

Stream zone	Trout	Grayling	Barbel	Bream
Fish fauna	Salmonid[1] fauna	Mixed fauna, salmonids[1] predominating	Mixed fauna, cyprinids predominating	Cyprinid fauna, with predators
	***Trout	***Trout and grayling	*Trout and grayling	
		**Running water cyprinids[2]	***Running water cyprinids[2]	*Running water cyprinids[2]
		*Accompanying cyprinids[3]	**Accompanying cyprinids[3]	***Accompanying cyprinids[3]
		*Accompanying predators[5]	**Accompanying predators[5]	***Accompanying predators[5]
			*Still-water cyprinids[4]	***Still-water cyprinids[4]

[1]Salmonids—Brown trout (*Salmo trutta*), grayling (*Thymallus thymallus*).
[2]Running water cyprinids—Barbel (*Barbus barbus*), chub (*Squalius cephalus*), hotu (*Chondrostoma nasus*)
[3]Accompanying cyprinids—Roach (*Gardonus rutilus*), rudd (*Scardinius erythrophtalmus*), dace (*Leuci cus leuciscus*).
[4]Still-water cyprinids—Carp (*Cyprinus carpio*), tench (*Tinca tinca*), bream (*Abramis brama*).
[5]Accompanying predators—Pike (*Esox lucius*), perch (*Perca fluviatilis*), eel (*Anguilla vulgaris*).

rapids are usually separated by pools. The more rapid stretches are inhabited by trout and grayling and the calmer waters in between by the running-water cyprinids, especially the barbel, chub (*Squalius cephalus*), and hotu (*Chondrostoma nasus*). Waters of the grayling zone are less oxygenated than those of the trout zone in summer but are still quite satisfactory in this respect. The stream bed is usually of finer material than is common in the trout zone and often is largely of gravel spread out and washed clean by the current.

Barbel Zone

Waters of the barbel zone (Figure 3) are streams and large rivers of moderate gradient and with moderate current and in which there is alteration of rapids and quiet waters. However, quiet water is much more extensive than in the grayling zone and is warmer. Water depth may be as great as two meters. The stream banks are often alternately differentiated as an erosion bank and a deposition bank. Although the fish fauna is dominated by "running-water cyprinids" (see Table 1), trout are to be found in the rapids. "Associated cyprinids" (Table 1) are abundant in the quieter waters of the barbel zone, especially the roach (*Gardonus rutilus*). Predatory fish, especially pike, perch, and eels, occur.

Bream Zone

Quiet waters, usually in the lower stretches of the streams (including ditches, canals, and large rivers), make up the bream zone (Figure 4). In these waters current is slight, summer water temperature high, and dissolved oxygen often fairly low. The water is often turbid and water depth may exceed two meters. Larger streams in the bream zone flow typically through a wide valley and often rivers of this type have been dredged and straightened to aid navigation. Calm-water cyprinids, especially bream, carp, and trench predominate, along with an abundance of roach. Predators, such as pike, perch, and eels, are fairly common.

The four fish-faunal zones are not always regularly disposed from upstream to downstream. Sometimes inversions are encountered in the succession of the zones. For example, the bream zone may precede the barbel zone where a flat region is situated upstream from hilly land with a steep valley. Such is the bream zone upstream from the confluence of the Saône River of eastern France with the Rhône. The Rhône itself is in the barbel zone. Another irregularity which may occur is absence of the characteristic fish from an association. This happens most often for the grayling which may be replaced in the grayling zone by the suiffe (*Telestes soufia*), a large minnow which is common in areas, such as the Pyrenees of South France.

LONGITUDINAL PROFILE OF STREAMS

The longitudinal profile of a stream, which indicates slope or gradient, affects distribution of fishes both directly and indirectly (Huet 1946 and 1949a). In rapid waters laterally compressed fish such as the bream have great difficulty in moving about and tend to be eliminated. Current velocity also influences water temperatures which in turn effect the respiration, oxygen consumption, reproduction, and growth of fishes. Because of high water temperatures and low oxygen, salmonids cannot live in the slow waters of the bream zone. Conversely, in the fast-flowing waters of the salmonid zones, low water temperatures in spring do not permit reproduction of many cyprinids. This may explain why cyprinids such as the chub (*Squalius cephalus*) do not inhabit the salmonid region even though these fish are strong swimmers.

A typical longitudinal profile of a stream, showing relationship of gradient to fish zones is shown in Figure 5. The River Lesse, which this profile represents, is located in Belgian Ardennes. From the study of longitudinal profiles of many European streams (Huet 1946 and 1949a) it is concluded that: (1) the slope or gradient of the stream bed is usually directly related to the fish fauna, and (2) in nearby rivers of comparable size, stretches with similar gradient have similar fish fauna. From these observations the following generalization, which I have called the *slope-rule*, has been formulated: *In given bio-geographical area, rivers or stretches of rivers of like breadth, depth and slope have nearly identical biological characteristics and very similar fish populations.*

It follows that if the slope-rule is correct—and it has been found to be correct in most Western European streams—that physical data describing the longtudinal profile of a stream, when used with data for average width of the stream itself, can be used to determine the fish zone of any section of the stream.

FIGURE 1.—Brook in the brown trout zone with rapidly flowing water.

FIGURE 2.—River in grayling zone with rapids alternating with fairly short quieter stretches.

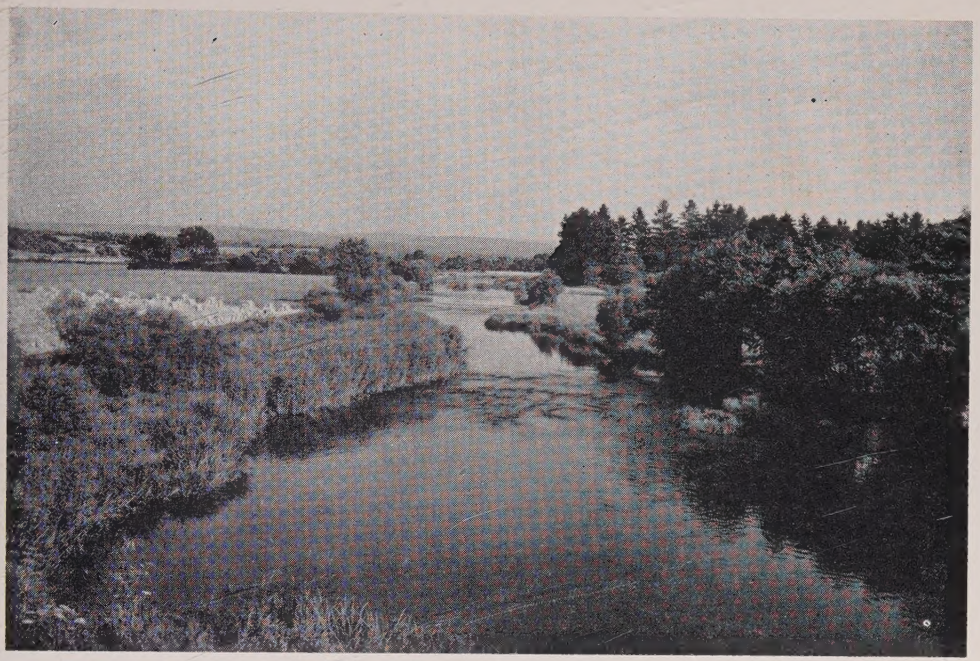
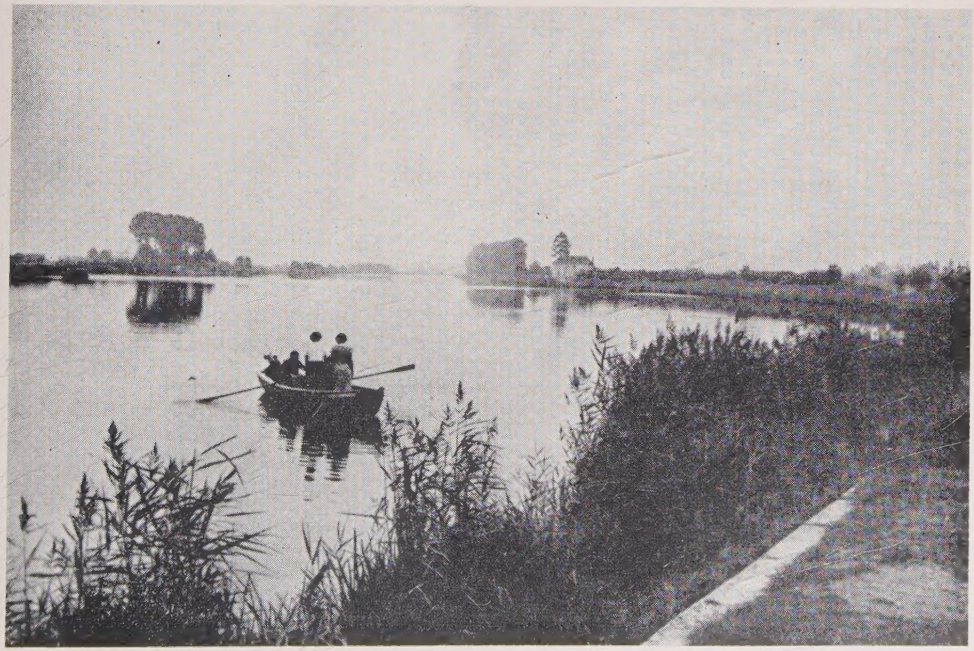


FIGURE 3.—Large river in the barbel zone showing alternation of short rapids and extensive quieter waters.



IGURE 4.—Large river characteristic of the bream zone with continuous quiet water.

A system of curves has been drawn showing relationship between stream slope and width and fish zones. Such I call a *slope-graph* (Huet 1947). Following are some examples of its use. A stretch of river 15 meters wide with a slope of 8 feet per thousand will belong to the trout zone; it will be in the grayling zone if the slope is 4 feet per thousand; it will be in the barbel zone if the slope is 1.5 feet per thousand, and be in the bream zone if the slope is 0.25 feet per thousand. Similarly a river 10 meters wide will be in the barbel zone if the slope is 2 feet per thousand, but if it has this same slope and is 40 meters wide it will be grayling zone (Figure 6.).

Use of the slope-graph makes possible a standard classification of fish zones in running water based on determinable physical characteristics rather than subjective impressions. This can facilitate ecology and taxonomic work on stream animals and plants. If good topographic maps of a stream are available and knowledge of widths at hand, surveys and inventories used as a basis for fish management can be greatly facilitated. Initial planning can be done in the laboratory and many preliminary visits to the stream eliminated. The slope-graph principal is also useful in solving problems related to stocking of native or exotic fishes. Locations suitable ecologically for the species to be stocked can be better and more easily identified. It might be noted, along this line, that acclimatization of the smallmouth bass (*Micropterus dolomieu*) has been successful in the Semois River of Belgium where the slope is comparable to American rivers in which this species does well. The slope-graph principal is also useful in evaluating present and potential pollution damage to stream and stocking of polluted waters. The nature and extent of pollution damage is often related to the kinds of fishes present and recovery of a stream from pollution damage is related to aeration which is often a function stream gradient.

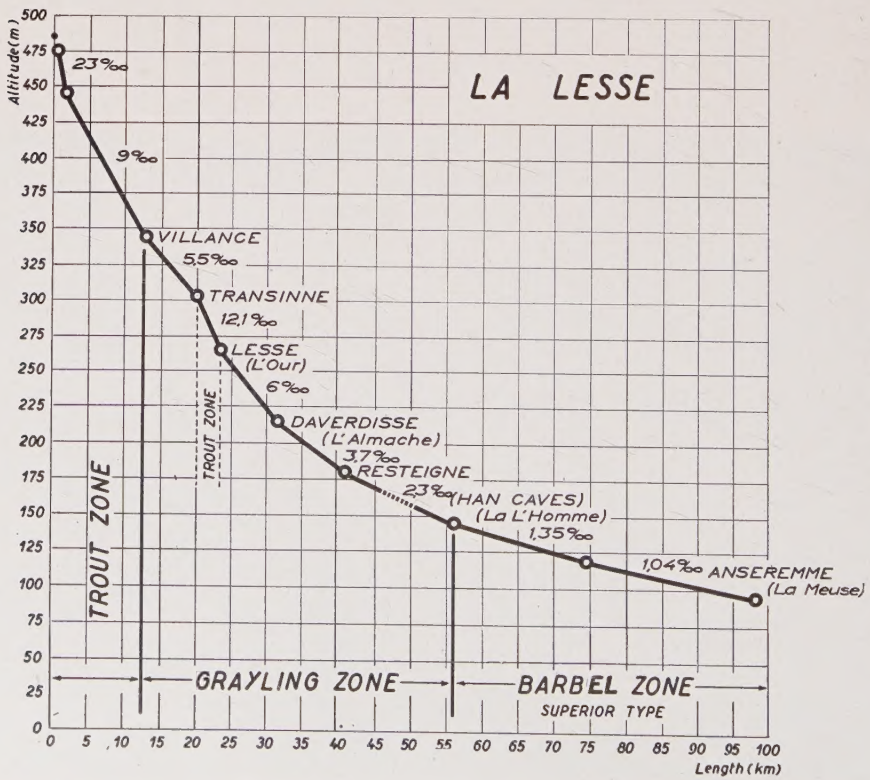


FIGURE 5.—Longitudinal profile of the River Lesse in Belgium showing gradient of the stream bed in three fish faunal zones.

CROSS-SECTION PROFILES OF VALLEYS AND STREAMS

In addition to knowledge of the longitudinal profile of streams, information on the shape of the valley through which the stream flows is of great value for understanding of conditions in the streams and fishery management of them. Kind and amount of sport and commercial fishing a stream offers is dependent upon stream width as is the amount and quality of water available for fish culture. Space along the stream for pond sites depends upon the shape of the valley (Huet 1949b, 1954).

Cross-Sections of Valleys

In those parts of Western Europe which were not covered by the Pleistocene glaciation, there are four principal types of valley cross-sections. The first type—valleys having the form of a non-horizontally trancated V—has three sub-types. The valley types are listed are illustrated in Figure 7.

Type 1: Valley having the form of a non-horizontally truncated V, (floodplain sloping).

Type 1a: Valley in the form of a non-truncated V (acute, right or obtuse angle). Stream in center of valley.

Type 1b: Valley in the form of a slightly and obliquely truncated V. Stream toward one side of valley.

Type 1c: Valley in the form of a rounded V or U. Stream in center of valley.

Type 2: Valley in the form of a slightly tilted and horizontally truncated V, the watercourse running along one side of the valley.

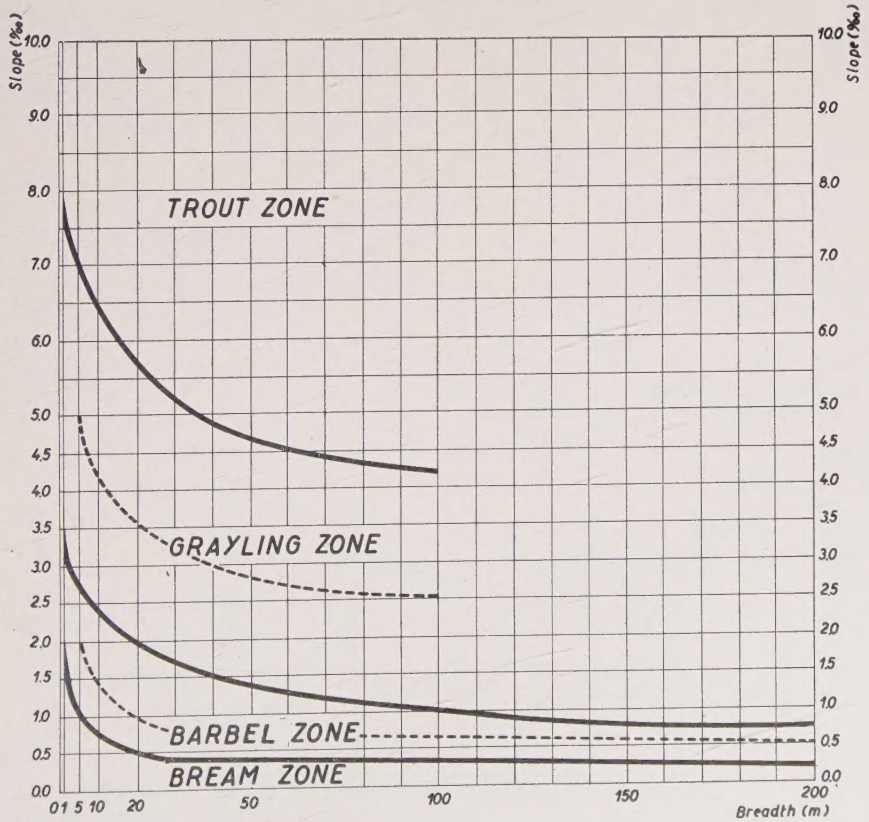


FIGURE 6.—Slope graph showing relationships between stream gradient, stream breadth, and fish faunal zones.

Type 3: Valley in the form of a strongly truncated V, the watercourse winding through the alluvial plain.

Type 4: Valley in the form of a very strongly or completely truncated V.

Cross-Sections of Valleys and Fish Faunal Zones of Streams

Relationships between cross-sections of the valley and the fish faunal zones of the watercourses in them are as follows (Huet, 1954):

Fish faunal zones	*Usual cross sections*
Trout zone (rapid waters)	Section of Type 1 (Types 1a, 1b or 1c): non-horizontally truncated V or partly and obliquely truncated V or rounded V.
Grayling zone (fairly rapid waters)	Section of Type 2: slightly and horizontally truncated V. the watercourse skirting the foot of one of the sides of the valley.
Barbel zone (slow waters)	Section of Type 3: strongly truncated V, the watercourse winding through the alluvial plain.
Bream zone (sluggish waters)	Section of Type 4: very strongly or completely truncated V.

It is important to note that the correlations between the length profile and the fish faunal zones in the running waters are practically without exception, but that the same is not true for correlations between the fish faunal zones and the cross-sections of the valleys. For the latter, correlations are frequently good but do not occur in more than eight-tenths of the cases.

Knowledge of cross-sections of valley and the extent and slope of their flood plains is of great importance in planning construction of ponds for fish propagation and providing an adequate water supply for them.

Valleys of Type 1a (non-truncated V, with acute, right or obtuse angle) are of little or no use for fish-culture because the banks of the streams are too steep. The construction of ponds requires erection of very high dams to inundate small areas. However, valleys with large obtuse angles may be an exception to this rule.

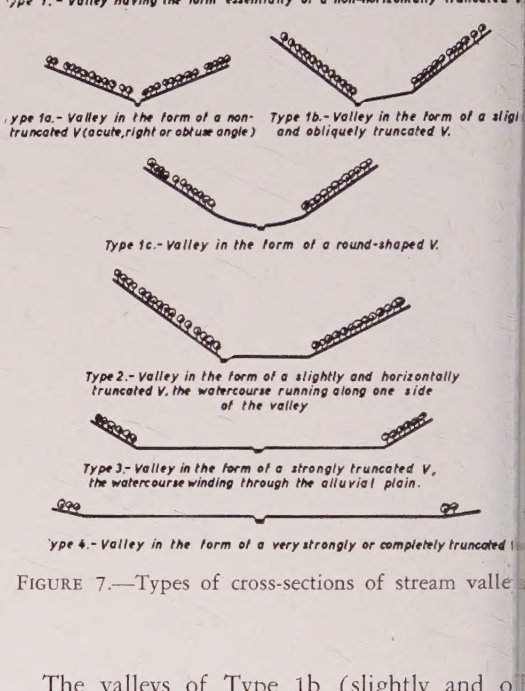

ype 1.- Valley having the form essentially of a non-horizontally truncated
ype 1a.- Valley in the form of a non-truncated V(acute,right or obtuse angle)
Type 1b.- Valley in the form of a sligi and obliquely truncated V.
Type 1c.- Valley in the form of a round-shaped V.
Type 2.- Valley in the form of a slightly and horizontally truncated V, the watercourse running along one side of the valley
Type 3.- Valley in the form of a strongly truncated V, the watercourse winding through the alluvial plain.
ype 4.- Valley in the form of a very strongly or completely truncated

FIGURE 7.—Types of cross-sections of stream valle

The valleys of Type 1b (slightly and o liquely truncated V) allow the construction diversion ponds. As such valleys are rath narrow, the ponds which can be installed a small.

The valleys of Type 1c (rounded V) a found in regions of more level topograp than is characteristic of the preceding typ Where the watercourses are of little impo ance for other use, these valley are genera suitable for establishing impoundments or version ponds.

In the valleys of Type 2 (slightly and ho zontally truncated V with the watercou running along the bottom of one of the side it is quite easy to create a succession of div sion ponds.

The watercourses in valleys of Type (strongly truncated V shaped valleys with t river winding through the alluvial plain) of excellent situations for the construction ponds. Construction possibilities are especia favorable when the ponds can be fed by late waters, such as springs that emerge along t bottom of the main valley.

In the valleys of Type 4 (strongly or tota truncated V-shaped valleys) the constructi of diversion ponds presents no difficulties the alluvial plain is slightly uneven. On t other hand if the plain is smooth, the situati is largely unsuitable for fish-culture. Lacki

sufficient slope, the filling and draining of ponds is difficult or impossible.

PHYSIOGRAPHIC DATA AND STREAM INVENTORY

A quite common difficulty in studies of streams and their biology is that there is no certain means for comparing the habitats considered. For such comparison, it is suggested, that the physiographic approach, using the *slope graph,* may be of considerable value. By it, biological zones in streams can be identified with some degree of certainty and these zones can be expected to be very similar to those identified in the same way in other waters of the same geographic and climatic complex. Inventory data, such as that obtained by electro-fishing, can be compared and changes in fish populations that have been brought about by the activities of man — fishing, channel changes to aid navigation, industrial use of water, and pollution—can be more certainly evaluated. It should be emphasized that in the physiographic approach to stream evaluation both the longitudinal and cross sections of the stream should be considered together with the shape of the valley through which the stream flows. All are important.

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Spawning Of North American Herring

LESLIE W. SCATTERGOOD, CARL J. SINDERMANN, AND BERNARD E. SKUD

U. S. Department of the Interior, Bureau of Commercial Fisheries Fish and Wildlife Service, Boothbay Harbor, Maine

ABSTRACT

The spawning of the North American herring on the Atlantic and Pacific coasts is compared. Spawning occurs somewhere on the North American continent during every month of the year. The spawning time progression on the Pacific coast is from mid-winter in the southern part of the range to early summer in the northern part. The Atlantic coast spawning has two peaks — spring and autumn; spring activities dominate in the northern part and autumn in the south. The range of spring-spawning temperatures on both coasts is comparable. While the major portion of spawning on the Atlantic coast takes place on rocky or gravel bottoms, the eggs of Pacific herring are most often attached to marine vegetation.

INTRODUCTION

The range of herring in North America extends generally north of 32° north latitude. *Clupea harengus* on the Atlantic coast is found as far south as Cape Hatteras and north to northern Labrador (Bigelow and Schroeder, 1953). Its Pacific counterpart, *Clupea pallasi,* ranges from near San Diego to the Arctic regions of northern Alaska. Recent studies in the Arctic by Wilimovsky (1954), Walters (1955) and J. G. Hunter of the Fisheries Research Board of Canada (correspondence) have verified early records that the distribution reaches at least to Cape Bathurst in the Beaufort Sea (Figure 1).

The ranges of the herring are great, yet these fish are abundant enough to be of considerable economic interest only in the centers of their range between Western Alaska and British Columbia, and Newfoundland and Maine. In those areas, the herring fisheries are pursued vigorously. With the exception of the fisheries for immature herring that are used for sardines in Maine and New Brunswick, the principal effort is devoted to capturing mature herring.

Herring deposit their sticky, demersal eggs somewhere in North American waters during every month of the year. The spawning seasons are usually referred to as spring and autumn. There is, of course, some spawning ing in summer and winter; the principal periods of egg laying, however, occur in spring and autumn. Spring spawning is defined here as January through July; and autumn spawning, August through December. This is recognized as a somewhat artificial division.

It is well to make the distinction between the two terms: (1) spring- or autumn-*spawning* fish and (2) spring- or autumn-*spawned* fish. In an area where both spring- and autumn-spawning activities occur, individuals spawning in one season may themselves have been spawned in another season. Thus an autumn-spawned herring may, upon reaching maturity, become either an autumn-spawning or a spring-spawning fish (Jean, 1956).

LOCATIONS AND TIMES OF SPAWNING

Pacific Coast

A northerly and westerly progression in spawning time along the Pacific coast from California to the Bering Sea was pointed out by Rounsefell (1930). Exceptions to this progression occur in local areas, but the general pattern holds for broad geographical areas (Skud ms.).

California. In the San Diego region, spawning may begin in mid- or late December, which is a month earlier than for more northerly parts of the California coast (Miller and Schmidtke, 1956). No large numbers of herring have been observed in the vicinity of San Diego, which may possibly represent the southern breeding grounds of this species. In the two principal California spawning areas, San Francisco and Tomales Bays, eggs may be deposited as late as March, but most of the spawning occurs in January and February.

Oregon. Information on Oregon herring is not extensive, because the species is of minor importance there. The principal spawning areas

FIGURE 1.—Distribution of North American herrings; *Clupea harengus* in Atlantic Ocean and *C. pallasi* in Pacific Ocean.

on the Oregon coast are Yaquina, Tillamook, and Coos Bays. Cleaver (1951) mentions that spawning herring visit those bays in the late winter months. According to Westrheim (personal communication of October 2, 1958), spawning occurs in Yaquina Bay from January to April and in Tillamook Bay from February to April.

Washington. In Washington waters, spawning has been reported from late December to early or middle May (Chapman, Katz, and Erickson, 1941). December spawning occurred on only one of the known grounds; in the Puget Sound region the major part of the spawning was during February and March. Spawning at any particular locality was usually completed within two weeks.

British Columbia. In recent years, more herring have been caught in the province of British Columbia than in all the other Pacific coast states and Alaska, combined. The catch data, coupled with the extensive spawning observed each year, indicate that this area is probably the center of abundance for the species on the Pacific coast of North America. The heaviest spawning occurs in the southern waters of the lower east coast of Vancouver Island. In southern British Columbia, Tester (1935) reported that spawning began during the latter part of February; in northern waters near the Alaskan border it began in the early part of March and ended in the last of April. More recently, Outram (1955) reported a spawning as late

as July 2 - 3 in Burke Channel in northern British Columbia.

Southeastern Alaska. On southeastern Alaskan beaches where spawning occurred each year, Skud (ms.) found that there was less variation in time of spawning than for areas where spawning did not occur annually. Spawning seldom started before mid-March, and all major activity was completed by the end of May. The heaviest concentration of egg depositions, which were generally located in the vicinity of Sitka, occurred in late March and early April. Occasional spawnings have been reported as late as June in other areas of southeastern Alaska, but they have never been as extensive as the earlier spawnings.

Central and Western Alaska. Rounsefell (1930) stated that spawning took place in April and May in Prince William Sound and Cook Inlet on the central Alaska coast. Farther west and north in the Kodiak-Afognak area, herring spawned in May and June. The most northerly record of spawning is in the Bering Sea near St. Michaels, Alaska, during the month of June (Nelson, 1887).

Atlantic Coast

The determination of spawning times and areas of the Atlantic coast herring is more difficult than for the Pacific species. Differences in spawning habits are responsible for this. The Pacific coast herring spawn in the intertidal zone, and the principal spawning areas are therefore readily observed. On the Atlantic coast, intertidal spawning has been reported only occasionally from Newfoundland (Tibbo, 1956). Egg laying generally occurs on bottoms too deep for the egg masses to be visible. Fortunately, where there are well organized herring fisheries for the mature fish, such as in Quebec and the Canadian maritime provinces, the spawning times and locations may be deduced from the condition of the gonads. Along the United States coast, however, no regular large-herring fishery exists, and, consequently, frequent samples of mature fish are not easy to obtain. However, plankton surveys for herring larvae do provide information concerning where and when spawning occurs. Such surveys have been carried on during the past few years in the Gulf of Maine by the joint efforts of biologists of the Fisheries Research Board of Canada and the Fish and Wildlife Service (Tibbo, Legare, Scattergood and Temple, in press).

Middle Atlantic Region. South of New England, herring are not abundant. Annual catches of a few million pounds are often made during the winter in New York and New Jersey, but only minor quantities are taken from Delaware south to Virginia. From the condition of the gonads of New Jersey and Maryland samples, the fish appear to be autumn spawners. Young larval herring were reported by Perlmutter (1939) from southwest Long Island, New York in October, indicating that there had been autumn spawning.

Southern New England. Block Island Sound off the coasts of Connecticut and Rhode Island has a winter fishery for spent herrings (Sanders, 1952). Merriman and Sclar (1952) reported the capture of small larval herring there in the autumn, but Wheatland (1956) showed that those fish were menhaden. Moore (1898) believed that spawning occurred during November in Block Island Sound and during October and November in southern Massachusetts and Vineyard Sound. There is no evidence of spring spawning in Southern New England.

Northern New England. In the Gulf of Maine, along the shores of Massachusetts and Maine, there have been many areas on which herring have spawned in the past (Bigelow and Schroeder, 1953). At the present time, according to the results of experimental fishing and larval herring surveys it seems that spawning is no longer so widespread. Now, the greatest concentrations of spawning fish in eastern United States waters appear to be on Georges Bank, about 100 miles east of Cape Cod. We do not know how important Georges Bank has been as a spawning ground in the past or whether the decrease in spawners along the New England coast has been accompanied by an increase on Georges Bank. Spawning in the Gulf of Maine and on the Maine coast occurs principally in September and October (Scattergood, 1952).

Canada. In Canada the spawning times and localities are better known than in the eastern United States. Some fish have been reported as spawning in April and May in the Bay of Fundy, making that area the southernmost limit of spring spawners. From Halifax south to Yarmouth and including the Bay of Fundy spawning is mainly in late August and September (Leim, 1957). Along the outer coast of Nova Scotia east of Halifax, there are two spawning seasons, a major one in May or early June and a minor one in September. This con

lition prevails in the Gulf of St. Lawrence, except that along the south and west coasts of Newfoundland the May and June spawning may be the only one. Some spawning may occur over a period from April to September, as Jean (1956) has reported for the Bay of Chaleur, Quebec.

It seems evident that the spawnings of the Atlantic coast are more complex than those of the Pacific. There are multiple spawning seasons within an area and almost continuous spawning for as long as six months in certain areas. The striking fact, however, is that while the Pacific coast has spring spawning, the Atlantic has both spring and autumn, with the autumn activities dominant in the southern part of the range and the spring being most important in the north. Among autumn spawners, there is some southward progression of spawning time — from late August in Nova Scotia to October in southern New England.

TEMPERATURE AT SPAWNING

The temperature during spawning on the Pacific coast ranges from 3.0° to 12.3° C and is similar to the range of Atlantic coast spring spawnings, 2.2° - 12.4° C, whereas, Atlantic fall spawnings occur at generally higher temperatures, 7.7° - 15.0° (Table 1). Surface temperatures are representative of spawning temperatures when fish spawn in shallow inshore waters, whereas, the water temperature in deep spawning areas varies widely from surface temperatures during certain seasons of the year. However, in autumn spawnings, such as those on Georges Bank, the differences at the surface and to depths of at least 100 feet are generally small because of the turbulent mixing of the waters.

TYPES OF SUBSTRATE

Bigelow and Schroeder (1953) reported that Atlantic herring spawn chiefly on rocky, pebbly, or gravelly bottoms, on clay to some extent, probably never on soft mud. They also noted that eggs were occasionally found sticking to anchor ropes of fishing vessels. Moore's (1898) observations of Grand Manan, N. B. confirmed these reports and added shells as an important substrate. These findings were in general agreement with Hodgson's (1957) descriptions of areas utilized for spawning in European waters.

In contrast, Pacific herring eggs are most often attached to various types of marine vegetation. Several authors, Hart and Tester (1934), and Chapman, Katz, and Erickson (1941), and others indicated that eel grass (*Zostera*) and rockweed (*Fucus*) were the preferred vegetation. Extension spawning on other seaweed such as vine kelp (*Macrocystis*) and bladder kelp (*Nereocystis*) was noted by Skud (ms.).

It is difficult to say whether or not these substrate differences between Atlantic and Pacific herring are merely associated with the depths and locations of spawning or whether the fishes of either coast actively seek out a particular substrate.

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TABLE 1.—*Time and water temperature for spawning of North American herring*

Source	Location	Spawning time	Temperature °C
Pacific			
Miller (1956)	California	Jan.–Apr.	8.0–10.0
Westrheim (communication)	Oregon	Jan.–Apr.	3.8–12.3
Outram (1955)	British Columbia	Feb.–Apr.	4.4–10.7
Skud (ms.)	Southeastern Alaska	Apr.–May	6.1–11.0
Rounsefell (1930)	Western Alaska	Apr.–May	3.0–5.5
Atlantic			
Tibbo (1956)	Newfoundland	May–June	8.0
Jean (1956)	Quebec—Bay of Chaleur	May–June	2.2–12.4
Bigelow and Schroeder (1953)	New Brunswick—Grand Manan	Aug.–Sept.	7.1–11.1
Bigelow and Schroeder (1953)	Massachusetts—Cape Cod	Oct.–Nov.	up to 12.8
Tibbo, *et al*, (In press)	Georges Bank	Sept.–Nov.	11.9–13.9

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Present Status of Commercial Fisheries in the United States [1]

DONALD L. MCKERNAN[2]

U. S. Bureau of Commercial Fisheries, Washington, D. C.

ABSTRACT

Fishery products continue to improve in quality and variety, but the commercial fisheries face serious economic difficulties. The catch in 1957 declined 10 percent in volume and 5 percent in value from the preceding year, but U. S. per capita consumption remained at about 10 pounds, the demand being supplied by increasing imports. Varying conditions in the several sections of the wide-spread fisheries are discussed and governmental programs of aid in technical and economic fields are mentioned.

INTRODUCTION

It is difficult to generalize on an industry so widespread and diversified as commercial fisheries. The fishing grounds of our fishermen (Figure 1) are spread along our coastline and beyond; in the Pacific from the Bering Sea to the coast of South America; in the Atlantic from the sounthern Gulf of Mexico to the Newfoundland Banks, and inland throughout the Midwest in the Great Lakes and broad Mississippi River drainage.

These products, with the recent advances in the technology of storage and transport, find their way freely from one end of the country to the other. There is no longer any reason why fresh, tasty fishery products cannot be enjoyed by people hundreds of miles from the seacoast.

Fishery products continue to improve, both in quality and in variety of the product. With all of these advances, one would suppose the fisheries of this Country would be entering an era of prosperity. Unfortunately, this is not the case. Many of our most important fisheries are in serious economic straits.

The problems of the fisheries fall into three broad categories: (1) The supplies of some fish are either scarce or uncertain and do not provide for a stable, profitable fishery; (2) the competition by other domestic protein foods, such as chicken, turkey, and various meat products, has become more acute, thus requiring greater expenditures for advertising and promotion and reducing the profit margin to the primary fish producers; and (3) competition from foreign fishery products is becoming acute. In several of our largest fisheries, a greater and greater share of the American market is being supplied by high-quality, low-priced foreign products. Domestic fish producers are frantically seeking means of equalizing production-cost differentials by various means ranging from seeking tariff and subsidy relief to searching for radically new fishing devices and new fishing grounds.

PRODUCTION

The 1957 catch of fishery products was 4.75 billion pounds valued at 351 million dollars to the fishermen. This was a decline of 10 percent in catch and 5 percent in value below the record United States catch of 5.25 billion pounds and 363 million dollars in 1956. These catches are compared with those since 1921 in Figure 2 and the several kinds of values per-

FIGURE 1.—Principal United States commercial fisheries.

[1] Report of Committee on Commercial Fisheries. 44th Annual Meeting, Philadelphia.

[2] Director, U. S. Bureau of Commercial Fisheries.

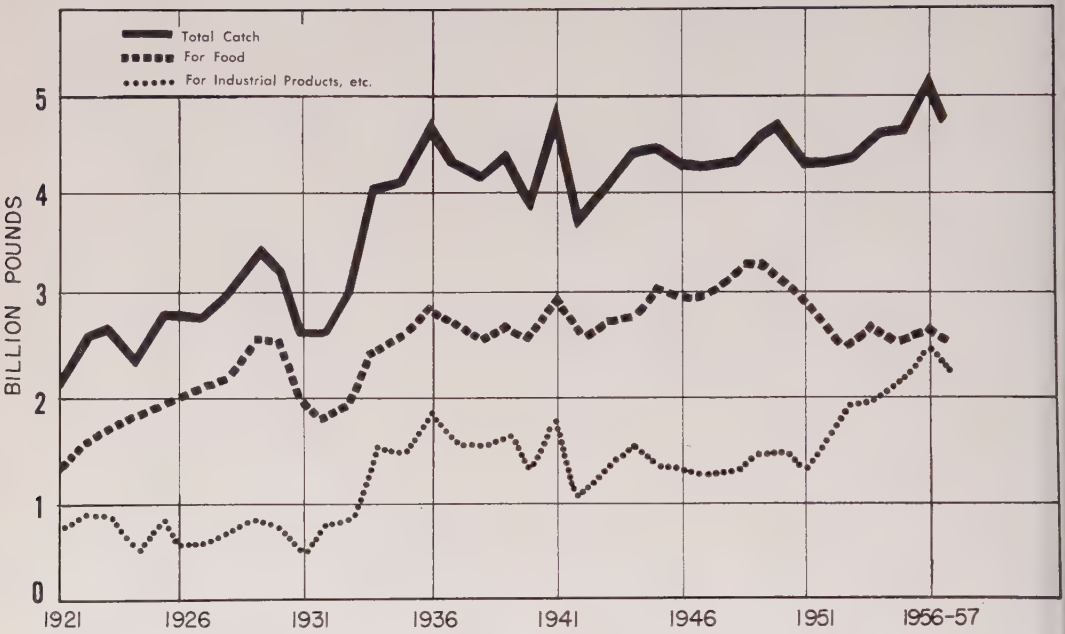

FIGURE 2.—United States catch of fish and shellfish, 1921-57.

		1956	1957
	The ORIGINAL value of fish and shellfish as taken from the waters was	$ 369,000,000	351,000,000
	When PROCESSED the value was	$ 732,000,000	667,000,000
	After WHOLESALE distribution the value was	$ 1,032,000,000	940,000 000
	And when RETAILED to the consumer the value was	$ 1,347,000,000	1,227,000,000

FIGURE 3.—Estimated value of fish and fishery products at production, processing, and distribution level 1956 and 1957.

ining to the 1956 and 1957 fisheries are nown in Figure 3.

The domestic production of fish and shellsh declined during the current year, 1958, ith catches of both edible and industrial fish elow 1957 levels. Landings during the first months of 1958 were 235 million pounds less an in the same period of 1957. On the basis f the catch through July, the total domestic tch may be predicted to fall between 4.2 nd 4.5 billion pounds.

It is of interest to note the volume and value f catch of some of the principal commercial shery species. Figure 4 shows both the tch and value of the six most important ecies from an economic standpoint. From a tch standpoint, menhaden outstrips in producon all of the other commercial species of h in the United States. Tuna and salmon, oth catch and dollar-wise, produce about the me quantity. The value of the shrimp to the shermen outstrips all other species by a conderable amount, closely followed by tuna and lmon, then by oysters, followed by menhaden. can easily be understood that an industrial sh, such as menhaden, would not bring as igh a price per pound on the market as a valable food-fish item such as shrimp. Nevertheess, the menhaden industry produces millions f pounds of valuable meal and oil. The meal sed in poultry production and the oil for huan consumption in Europe and other parts f the world are valuable fisheries products.

The trend towards supplying our requirents for food by increasing imports of fish nd shellfish continues. During the period 1950 to 1957 the United States supply of edible fishery products obtained from the domestic catch declined from 3.3 billion pounds to 2.5 billion pounds—a decrease of 23 percent. During the same period, imports increased from 1.0 billion pounds to 1.5 billion pounds (these weights are round-weight bases), which was an increase of 47 percent.

CONSUMPTION

The consumption of fishery products on an edible-weight basis continues at about 10 pounds per capita in the United States. Despite the great variety in fish and shellfish available to consumers and the rapidly improving emphasis on the quality and marketing techniques that have occurred within the industry in recent years, the consumption of fish per individual has not shown the same increase as meat and poultry products.

REGIONAL PROBLEMS

Viewing the production in various parts of the country will give a better insight into current production in our commercial fisheries.

The United States production of groundfish and ocean perch fillets from New England continued to decline in 1957, with a catch of 97 millions of pounds (Figure 5). Imports of groundfish fillets reached a record 141 million pounds. The trend of domestic versus foreign fisheries can be well illustrated in groundfish supplies: the peak production of United States groundfish fillets occurred in 1951 when 150 million pounds were produced.

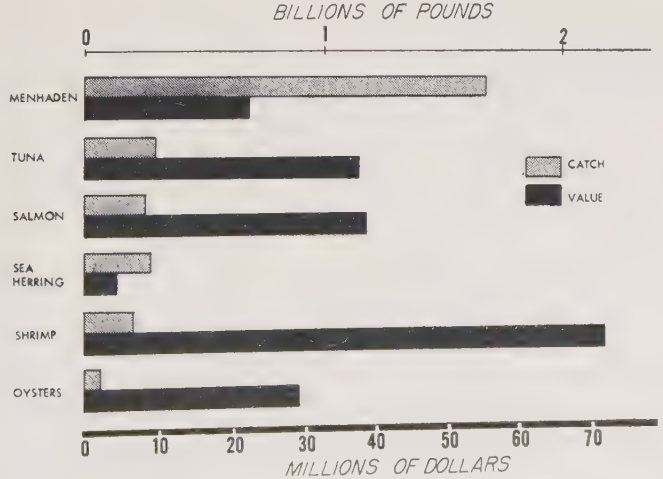

FIGURE 4. Volume and value of catch of principal commercial fisheries, 1957.

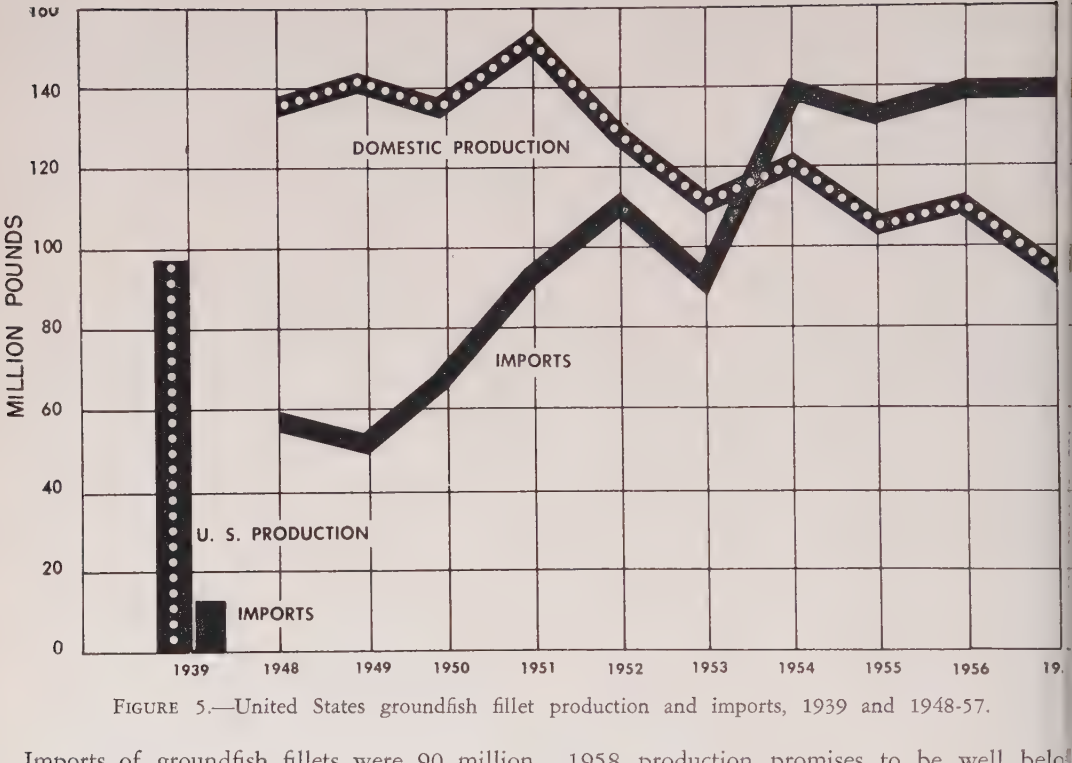

FIGURE 5.—United States groundfish fillet production and imports, 1939 and 1948-57.

Imports of groundfish fillets were 90 million pounds, or 37 percent of consumption. In 1957, United States production was 97 millions of pounds while 141 million pounds of fillets were imported, or 60 percent of the total consumption.

In the Central Atlantic States the menhaden fishery overshadows all others. This fishery, which expanded rapidly in recent years, declined during 1957 and 1958 (Figure 6). The 1958 production promises to be well belo the peak of 2.1 billion pounds in 1956. It believed that the improved catch in the Gu of Mexico this year will counterbalance t very poor production in the North Atlant A total 1958 production of menhaden simil to the 1.7 billions of pounds landed duri 1957 is anticipated. There are signs of a ve successful crop of small menhaden whi presages well for the 1959 and 1960 seaso

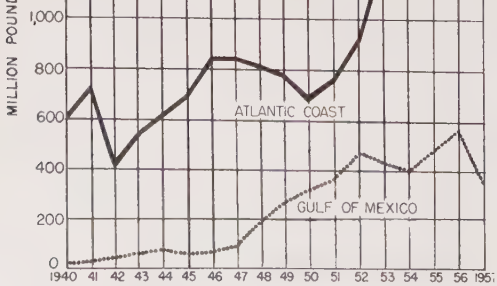

FIGURE 6.—Catch of menhaden on the Atlantic coast and in the Guf of Mexico, 1940-57.

Oyster production on the Atlantic coast a pears down this year. A serious crisis dev oped during the past year in Long Isla Sound where an invasion of starfish has furth reduced the oyster production. Almost sup human efforts by oystermen show some hop of salvaging part of the crop of oysters in t region. Late reports indicate a good set strike of young oysters in Long Island Sou in 1958. This could well mean the salvati of this hard-hit industry.

Shrimp production in the South Atlantic a Gulf States has been spotty. The 1957 cat was 205 million pounds, or 9 percent less th 1956. The poor production during this p year was largely attributed to exceptiona poor fishing weather and a failure of t white shrimp in the central Gulf coast ar

Production during the current season appears more normal and it may be that a further drop in domestic production will be avoided.

Imports, primarily from Mexico, have increased rapidly in recent years and now enjoy about 30 percent of the American market (Figure 7).

The Great Lakes fishing industry has been confronted in recent years by erratic and sometimes drastic changes in the species and size composition of fish stocks. The invasion of the sea lamprey has all but destroyed the lake trout in Lakes Huron and Michigan and has contributed to its drastic depletion in Lake Superior. The lamprey has also contributed to the reduction of whitefish, walleyes, and large chubs in areas where it has reached extreme abundance. The introduced smelt has been abundant in Lakes Michigan and Huron since the 1930's, but has just recently attained prominence in Lakes Superior and Erie. The exotic alewife which entered the Great Lakes from the Atlantic in the 1930's has reached a peak abundance in Lakes Erie and Huron, is now undergoing rapid expansion in Lake Michigan, and just becoming established in Lake Superior.

Changes in the composition of Great Lakes fish has almost eliminated fishing activities in some areas, while in others the industry has been able to exploit new or under-utilized species, sometimes to considerable advantage. Adaptation of the commercial fishery to the changing composition of stocks is revealed by the catch statistics. The United States catch during the past 10 years of record (1947-1956) averaged 77 million pounds and varied less than 10 percent from the mean with no upward or downward trend. The catch in Canada more than doubled from 20 to over 40 million pounds during these 10 years and averaged 31 million pounds. Although the increase in Canadian production produced an upward trend in the total catch (average 109 million pounds) the total value of the catch to the fishermen (average 16 million dollars) over the 10-year period did not increase. Thus, the industry has adjusted to the changes in the composition of the fish populations, but at an economic loss. The average price per pound of the catch has dropped from about 16.5 to 13.5 cents over the past 10 years. Depletion of species suited for human consumption, and for which methods of capture and markets were well developed, contributed to the decline in value. The fishery is producing more fish through increased effort and expense, but without an increase in return.

On the Pacific coast, despite problems of domestic production, the pack of canned tuna during the first 7 months of 1958 was the

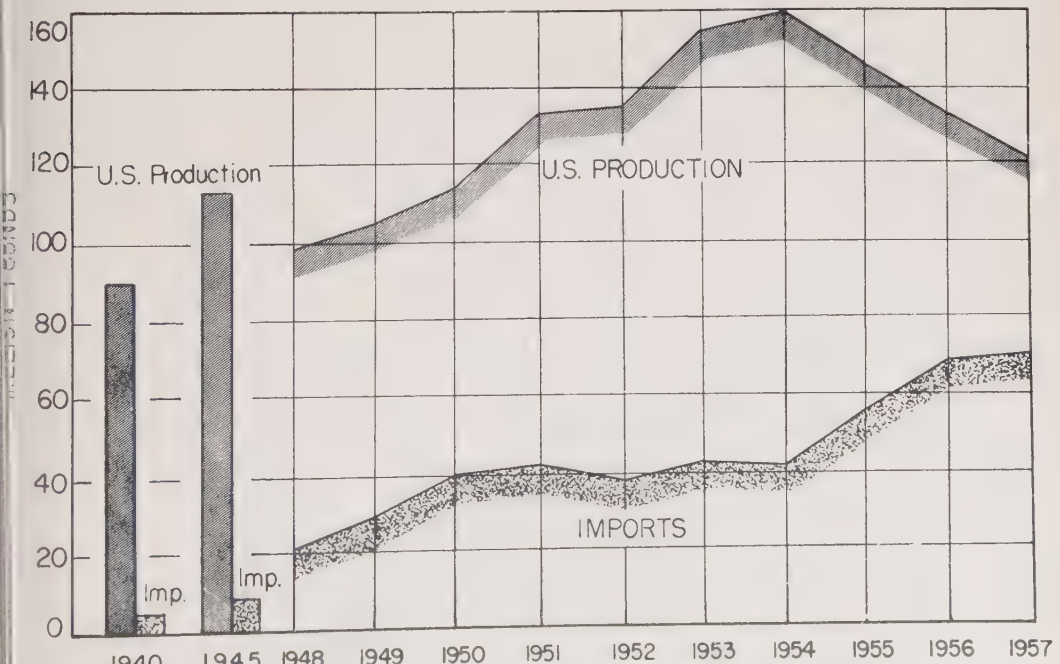

FIGURE 7. United States shrimp production and imports, 1940, 1945, and 1948-57.

largest in history. Tuna production by domestic fishermen increased modestly during the current season, primarily due to the consistent fishing by United States boats. A year ago, long delays in unloading the catch had reduced fishing time and the resultant catch.

A change occurred in the method of marketing raw tuna landed by tuna clippers, members of the American Tunaboat Association, with the introduction of an auction system. Prices for tuna have risen somewhat and fishermen have been making more trips because the auction system has accelerated unloading of the vessels.

The United States tuna production continued at about a constant level during 1957. Figure 8 shows the rapid increase in imported tuna, while at the same time the United States pack has remained constant or has declined slightly. The bars on the lefthand margin show the relationship between imported tuna and United States production in 1939. Thus it can be seen how the imports of tuna, primarily from Japan, have accounted for most of the increase in consumption within the United States.

The production of the Pacific sardine remained low, but the first significant change in water quality in recent years occurred in 1957. Warm water moving north along the southern California coast produced the first successful year class of sardines in many years in 1957. While it is not expected that this northerly spawning of sardines will result in an unusual increase in catch during 1958, anticipation is keen that the recent change in the inshore oceanography and what appears to be a direct response of the sardine populations to this change will provide the missing link of information as to the cause of the recent disappearance of the Pacific sardines off the California coast. Incidentally, survival and recruitment of the more northern spawning will, of course, bring about a substantial increase in the catch when these age classes are fully recruited into the fishery.

The 1958 run of sockeye salmon into the Fraser River was predicted to be one of the largest in recent history. After keeping the International Fisheries Commission and industry waiting for nearly 2 weeks beyond its normal appearance, the famous Adams River run of the Fraser River made its appearance. It is expected that the run may well reach 15 million fish.

Farther north the Alaskan salmon season was coming to a close after a generally successful season. The pink salmon runs showed

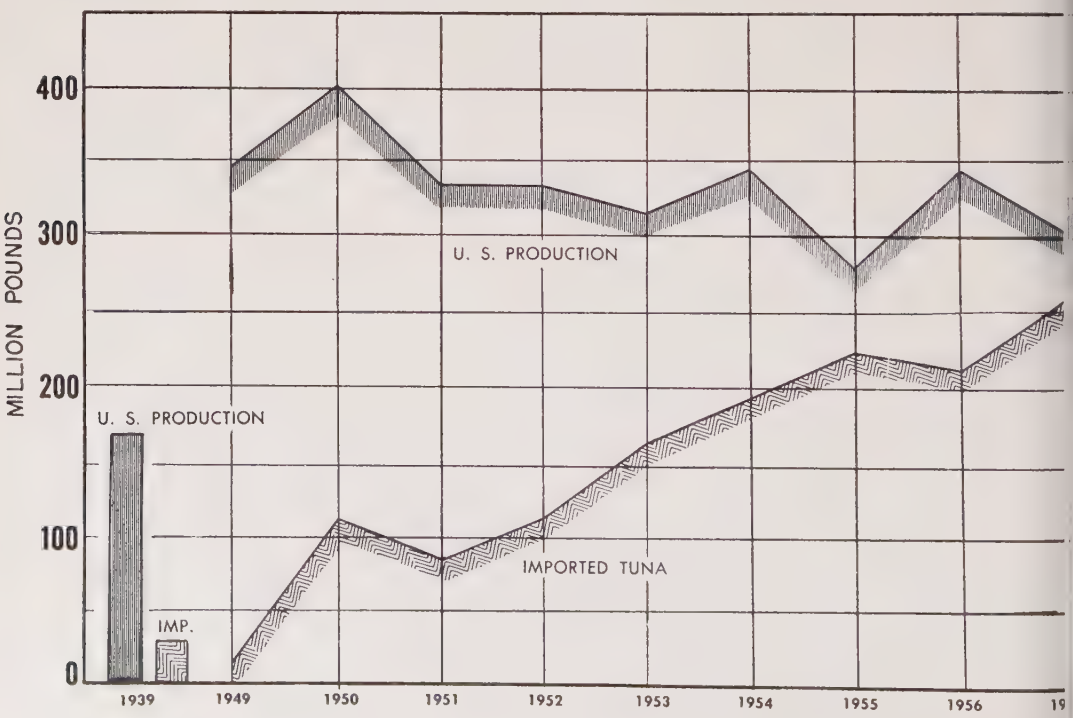

FIGURE 8.—United States tuna production and imports, 1939 and 1949-57.

a marked increase in abundance, overcoming the expected poor red or sockeye catch to produce a total pack of 3 million cases of salmon —the largest pack in recent years.

Bristol Bay red salmon production, experiencing a natural low-cycle production, was further reduced by the harvest of this run on the high seas by the Japanese high-seas fishery. Current studies under way in the North Pacific reveal large-scale intermingling of salmon of North American origin with those of Asian origin in areas of the North Pacific under intensive fishing by the Japanese.

DISCUSSION

As can be seen from the foregoing discussion, there are many problems of both production and marketing facing the United States commercial fisheries. Coordinated plans are under way through such agencies as the Pacific Marine Fisheries Commission, the Atlantic States Marine Fisheries Commission, the Gulf States Marine Fisheries Commission, and the several international fishery bodies to draft long-range programs designed to bring about solutions to many of the problems facing the industry. For example, through the Gulf States Marine Fisheries Commission and the various States involved, comprehensive plans for a long-range study of the estuarine environment of our commercial fishes is under way.

Such a program envisages a study of the inshore environment from the production of food and the physical and chemical characteristics of the inshore waters to comprehensive studies on the effects of dredging and mechanically changing the physical characteristics of bays and estuaries which are known to be of vital importance to the production of our major fish species on the Atlantic and Gulf coasts. Progress seems rapid on this project, and cooperative studies between the States and Federal Government probably will be implemented during the coming year. A great deal of information is available in the files of the various agencies, and some excellent papers have already been published. Unfortunately, a great deal of information is still lacking and much of the available information has not been applied in dealing with the changing environment of these inshore fisheries.

Serious problems of another sort face such important fisheries as the New England ground fishery and the California tuna industry. In these fisheries the domestic producers are rapidly losing out to foreign production. Our domestic fleets of fishing vessels are becoming obsolescent and, despite the fact that the resources are at a relatively high level of productivity, competition has so reduced profit that the industries supported by these great resources are in a state of decline. Programs are under way to study means of improving the economic status of these industries. Most of these studies involve the economics of the industry and vary from attempts to find more economic and efficient ways of harvesting the fish to improvements on the quality of the final marketed product.

The next few years promise to be critical ones for the fishing industry. With international problems increasing in the American fishery scene and with the high competition from both foreign and domestic products, our commercial fisheries are truly facing a critical period. Bold, positive programs by Government and industry need to be developed and implemented immediately in order to forestall further losses in this great food-producing industry.

Relationship of Size and Age to Time of Annulus Formation in Brook Trout

James T. McFadden
Department of Zoology and Entomology, The Pennsylvania State University, University Park, Pa.

ABSTRACT

Scale samples were taken from brook trout in Lawrence Creek, Wisconsin on April 12, 13, and 16, 1956. During this period some of the fish had formed identifiable annuli for the current year and others had not. It was found that a larger proportion of the younger fish (I's and II's) had identifiable annuli than fish of Age Group III. Among fish of the same age, more of the larger ones had completed the current annulus.

Determination of the age of fishes by means of scales or other skeletal structures has become one of the basic tools of fishery science. In order to validate these determinations, it has been necessary to identify the year-mark, winter-ring or annulus, as it has variously been named, and to determine the time of its formation. This paper deals with some of the variability to be found in the time of annulus formation in the brook trout (*Salvelinus fontinalis*) and suggests some of the factors which may cause this variability.

Annulus formation has been shown to take place earlier in the season among younger fish than among older fish of the same population for several species: brook trout (Baldwin)[1], trout and whitefish (Nümann and Sella 1943), herring (Hodgson 1925, and Lea 1919), bluegills (Bennett, Thompson, and Parr 1940), and rock bass (Hile 1941). A sizable collection of scale samples from the brook trout population of Lawrence Creek in central Wisconsin happened to be made at the time when the annulus for the current year had already been formed on some fish, but was not yet identifiable on others. This circumstance afforded the opportunity to determine the effects of size and age on time of annulus formation in this population.

Scale samples were taken from 428 brook trout captured in the first mile of stream below the headwaters, on April 12, 13, and 16, 1956. The fish were collected with 230 volt, 2500 watt, direct current, electrofishing gear. All scales were taken from the side of the fish, immediately anterior to the caudal peduncle. Scale samples were mounted in glycerin-gelatin on microscope slides and examined through a binocular microscope.

The annulus on brook trout scales has been described by Cooper (1951) as follows: "The annulus . . . is a break in the growth pattern of the circuli. The exact limit is set as the outermost circulus deposited before the resumption of rapid growth in the spring. The scale must begin to grow anew before the annulus can be identified." Proceeding from this definition, it was possible to recognize new annuli on the scales of Lawrence Creek brook trout whenever the first trough of the new season's growth had reached a width in excess of the widths of the troughs between the "winter" circuli immediately preceding it. The circulus or ridge which constitutes the annulus is often particularly pronounced, and this characteristic was also used in the recognition of newly completed annuli.

The criteria cited above provide objective means of identifying annuli. However, within the range of continuous variability from *no annulus* to *well defined annulus* a rather arbitrary dividing line must somewhere be drawn. The scales from each fish were classified as either lacking or bearing a recognizable new annulus, and in a small number of cases some subjectivity in the decision must be admitted.

Groups of fish of different sizes and ages were compared to determine the relative proportions which had formed recognizable annuli (Table 1). The percentage of older fish with completed annuli was lower than that for younger fish. Among fish of the same age, a higher proportion of the larger ones had completed recognizable annuli. Among fish of the same size, the percentage of completed annuli was higher in the younger age groups.

[1]N. S. Baldwin. A study of the speckled trout, *Salvelinus fontinalis* (Mitchill), in a Pre-Cambrian lake. Univ. of Toronto Master's Thesis, 1948.

TABLE 1.—*Variations due to size and age in the proportion of brook trout showing a newly completed annulus.*

Age group	Total length of fish in inches	Number of fish	Percentage of fish with recognizable 1956 annuli
	3.0-3.9	13	53.8
	4.0-4.9	59	62.7
I	5.0-5.9	105	88.6
	6.0-6.9	25	88.0
	Sub-total	202	78.7
	4.0-5.9	8	50.0
	6.0-6.9	60	58.3
II	7.0-7.9	88	69.3
	8.0-8.9	43	74.4
	Sub-total	199	66.3
III	7.0-11.9	27	29.6
	Sub-total	27	29.6

On the basis of these observations it is inferred that, within the same population, younger trout form annuli earlier in the spring than older trout, even when no difference in length exists.

A similar analysis was made of scales collected from brook trout in the section of Lawrence Creek immediately downstream from the area in which the sample discussed above was taken. Practically all of the fish in this downstream area had completed formation of the new annulus. Therefore, variations in time of annulus formation also occur among different spatial segments of the same population.

This work was conducted at the Wisconsin Conservation Department's Lawrence Creek Research Station. The help of Dr. Edwin L. Cooper and Mr. Robert T. Probst who reviewed the manuscript is acknowledged.

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Effects of Management and Winter Oxygen Levels on the Fish Population of a Prairie Lake

JOHN B. MOYLE[1] AND WILLIAM D. CLOTHIER[2]

ABSTRACT

Take of carp by annual intensive winter seining from Lake Traverse, a shallow 11,000-acre lake, declined from 58,000 to 500 pounds per seine haul during the period 1951-1958. Concurrently, the catch of crappies, which were returned to the lake, rose from 2 to 84 thousand fish per haul. Bullheads were also removed, mostly by hoopnets, in amounts ranging from 7 to 56 pounds per acre per year with greatest removal in 1956-57. Average catch per hoopnet pocket was 25.3 pounds in 1950-53 and 65 pounds in 1956-58.

Walleyes, mostly as fry, were stocked in all 13 years of the 1945-1958 period considered and northern pike and rescued black crappies in some of these years. It appears from consideration of winter oxygen levels and subsequent take of game fish in seines that walleyes (and probably channel catfish and bluegills) did not survive as well at winter oxygen levels below 5 p.p.m. as above this level. Northern pike, crappies and rough fish were more tolerant and evidently survived well when oxygen levels fell to near 1 p.p.m.

Lake Traverse, on the Minnesota-South Dakota boundary, is a shallow and fertile reservoir lake that has long had large populations of rough fish, especially bullheads and carp. During the 13 years, 1945-1957, it has been subjected to rather intensive management, especially stocking of game fishes and removal of rough fish. Results of this management and the effects of winter oxygen levels on fish in the lake are described.

LAKE TRAVERSE AND ITS FISHES

Lake Traverse is an elongated natural lake lying in the wide valley of Glacial River Warren, once an outlet of Glacial Lake Agassiz. The lake is about 16 miles long and 2 miles wide and is the main headwater of the Red River of the North. It receives water from the Mustinka River, a small stream draining farm lands in Minnesota, several small creeks, and springs—especially at the south end of the lake. These springs, which were early described by Winchell (1888, p. 533), are of special fishery interest, for in and near them fish concentrate in winter if dissolved oxygen becomes low.

In 1947 a dam was built across a constriction in the valley separating Lake Traverse from Mud Lake just to the north. Location of this dam, which was built by the Corps of Engineers U. S. Army for flood control, is shown in Figure 1. The area of Lake Traverse, is 12,400 acres at maximum pool elevation and 10,900 acres at conservation pool level. For the purpose of calculating fish yields the area of the lake is considered to be 11,000 acres. At conservation pool level Lake Traverse has a maximum depth of 16 feet and an average depth of about 10 feet, but much of it—at least half—is too shallow for the operation of hoopnets and seines. The center of the lake forms an elongate trough that is easily seined and, in winter, fish tend to concentrate in this deeper water.

The watershed is fertile farmland and the soils are of gray (Keewatin) drift lying over and incorporating salt-rich Cretaceous rocks. Soil and climate cause the water to have a high mineral content and to be very fertile. The lake is of the alkali or sulphate-water type characteristic of many lakes of South Dakota and of southwestern and extreme western Minnesota (Moyle, 1956). A chemical analysis in p.p.m. of a water sample collected July 13 1945 is: total alkalinity, 145.0; sulphate ion 483; chloride ion, 31; total phosphorus, 0.15; total nitrogen, 0.97.

Fishes known to be present in the lake are carp (*Cyprinus carpio*); bullheads (*Ictalurus nebulosus* and *I. melas*); white sucker (*Catostomus commersoni*); northern pike (*Esox lucius*); walleye (*Stizostedion vitreum*); yellow perch (*Perca flavescens*); crappies (*Pomoxis nigromaculatus* and a few *P. annularis*); channel catfish (*Ictalurus punctatus*); largemouth bass (*Micropterus salmoides*); and the min

[1]Minnesota Department of Conservation, St. Paul, Minnesota.

[2]Oregon Fish Commission, Newport, Oregon. Formerly with the South Dakota Department of Game, Fish and Parks, Pierre, South Dakota.

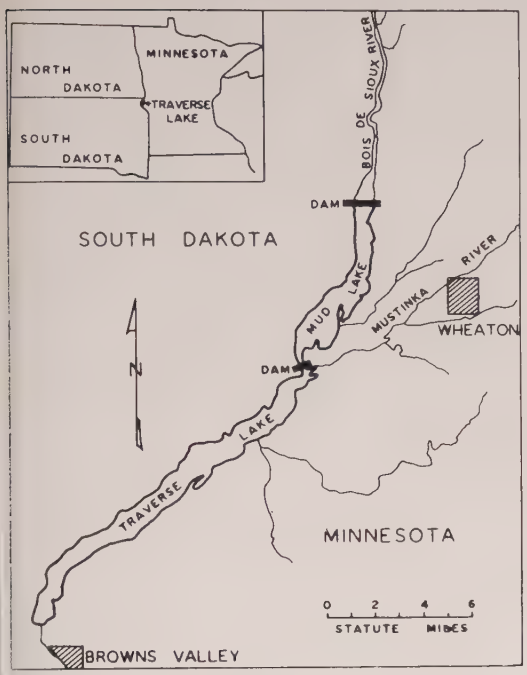

FIGURE 1.—Traverse and Mud lakes on the Minnesota-South Dakota boundary, showing location of flood control dams. Fish-removal operations are centered at Browns Valley and winter seining done in the central trough of the lake. Most hoop netting has been carried out on the Minnesota side.

nows, *Notropis dorsalis, N. heterolepis,* and *Pimephales promelas*. Bluegills (*Lepomis macrochirus*) have been stocked in the lake in recent years. Orange-spotted sunfish (*Lepomis humilis*) and Iowa darter (*Poecilichthys exilis*) were taken from the lake in 1949.

Lake Traverse has considerable sport fishing, especially for bullheads, crappies, walleyes, and northern pike, but quantitative estimates of the sport-fishing yield have not been made. It is fished by angling, both from boats in summer and through the ice in winter from shelters or "fish houses." During the winter of 1954-55 there were about 500 fish houses on the ice and about 300 during the winter of 1955-56. Since winter oxygen levels are often low, it is unlikely that walleyes, largemouth bass, and catfish would occur in Lake Traverse except for stocking after unfavorable winters.

WINTER OXYGEN CONDITIONS

Because of the high fertility and shallowness of the lake, it is turbid with plankton algae in summer and oxygen levels often become low in winter if snow blankets the ice. As a standard fish-management practice, dissolved oxygen determinations are made during the winter (January-March) on many shallow lakes, including Traverse, by Minnesota fish-management personnel to determine the necessity for fish-rescue operations or for opening lakes to "promiscuous fishing" if winter kill threatens. On Lake Traverse, oxygen analyses have been made at 4 to 7 scattered stations in the deeper water areas. Several series of analyses have been made in those winters when oxygen depletion threatened. Series of analyses for the years considered are: 1948—7; 1949—3; 1950—2; 1951—11; 1952—2; 1953—1; 1954—1; 1955—4; and 1956—5.

Dissolved oxygen analyses were not made in the winters of 1957 and 1958 because there was little snow on the ice and oxygen levels presumably were high. An analysis from Mud Lake, immediately above Lake Traverse, was 15.5 p.p.m. on February 2, 1958.

Standard Winkler analysis was used, and samples were usually taken 3 feet under the ice. An attempt was made each winter to get one series of samples when dissolved oxygen, as judged by conditions in other lakes and the past history of Lake Traverse, was likely to lowest. Minimal series of oxygen readings are listed in Table 1.

TABLE 1.—*Minimal series of oxygen determinations in Lake Traverse during winters of 1948-1956*

Date	Dissolved oxygen (p.p.m.)[1]	Rating[2]	Field notes[1]
Feb. 10, '48	0.5, 0.8, 0.8, 1.0, 1.1	C	Dead fish in seines
Feb. 8, '49	0.7, 1.3, 1.7, 1.8, 2.0, 2.8	L	Cribbed rough fish in distress
Feb. 3, '50	6.3, 7.5, 7.6, 8.3, 9.4	H	No fish in springs
Feb. 14, '51	0.9, 1.2, 1.7, 2.0, 2.2, 2.7	L	"
Feb. 28, '52	1.4, 5.9, 6.0, 7.5	L to H	"
Mar. 1, '53	6.7, 6.8, 10.1, 10.5, 12.3	H	"
Feb. 3, '53	5.3, 7.1, 7.6, 8.8, 9.5, 9.5	H	Bare ice
Feb. 25, '55	4.6, 7.3, 7.7, 11.6	L to H	Bare spots on ice
Feb. 21, '56	0.3, 0.4, 0.6, 1.3	C	Fish in springs

[1] Analyses and field notes by Jerome Sevada and Goyko Oklobzija.

[2] Winter oxygen conditions are categorized in the "Rating" column as critical (C) all reading of the lowest series of the winter below 2.0 p.p.m.; low (L) - some readings between 2.0 and 5.0 p.p.m.; and high (H) all reading above 5.0 p.p.m This categorization largely follows Ellis, Westfal[l] and Ellis (1946) and Tarzwell (1957).

As shown in Table 1, lowest oxygen levels were usually found in Lake Traverse in February. However, at no time during the 1948-57 period were concentrations below 0.3 p.p.m. observed. Oxygen concentrations in any series of analyses often differed considerably, reflecting local lake conditions and especially variation in thickness of ice and snow cover—differences which affect light penetration and photosynthetic production of oxygen under the ice (Croxton, Thurman and Shiffer 1937; Greenbank 1945). In several of the years dead crappies were noted under the ice but there have been no extensive winterkills of crappies or rough fish. It seems likely, however, that low but not lethal oxygen levels have at times favored the bullheads and carp.

In lakes such as Traverse, where reduction of winter oxygen levels is often gradual, fish are subjected to a long period of conditioning to low oxygen levels and lethal levels are somewhat lower than has sometimes been found experimentally. For example, Moore (1942), using caged fish placed under the ice in water of known oxygen concentrations, found that bullheads died in 48 hours at .3 p.p.m., largemouth bass and northern pike at 2.3 p.p.m., and crappies at 1.4 p.p.m. In Lake Traverse crappies were distressed but alive at 1.1 p.p.m. As will be shown, northern pike evidently survived at similar low levels. Scidmore (1957, and private communication), who observed directly the effect of low winter oxygen levels on game fish in two southern Minnesota lakes, reports that black and white crappies, bluegills, walleyes and white bass (*Roccus chrysops*) died when oxygen levels fell from 1.6 and 1.4 p.p.m. to 0.4 and 0.2 p.p.m. Olson (1932) observed dead carp in a Minnesota lake with 0.8 p.p.m. oxygen and live carp in the same lake where oxygen "had been a trifle higher." In Lake Traverse game fish and white suckers moved into the vicinity of springs when oxygen fell below 2.0 p.p.m. and carp held in cribs were distressed at 1.0 p.p.m. Little is known about the relationship between lengths of exposure to low oxygen levels and mortality of fish under ice. It is quite generally agreed, however, that continued oxygen concentrations below 5.0 p.p.m. are unfavorable to game fish in streams (Ellis, Westfall, and Ellis 1946; Tarzwell 1957).

ROUGH FISH REMOVAL

In an attempt to better sport fishing, roughfish—carp and bullheads—have been removed from Lake Traverse nearly every year during the 1945-1957 period (Tables 2 and 3). The fishing is done by commercial fishermen, working under contract, and using hoopnets and seines. All netting is carried on under close supervision of state fishery personnel who weigh and grade the rough fish, and count and record all game fish before they are returned to the lake. A percentage of the sales from the rough fish is collected to finance supervision. Fishing contracts are let by the fiscal years (July 1 to June 3). Seining is done under the ice from December to mid-March and hoopnets are usually fished from September through May.

TABLE 2.—*Carp and bullheads removed from Lake Traverse by nets, 1945-1957*
[Dash (—) indicates no fishing]

Fishing[1] year	Pounds removed per year		Pounds removed per acre	
	Carp[2]	Bullheads[2]	Carp	Bullheads
1945–46	—	*755,655	—	*35
1946–47	802,760		73	
1947–48	—	155,752	—	14
1948–49	1,072,700	—	98	—
1949–50	420,775	320,962	38	29
1950–51	2,078,150	164,708	189	15
1951–52	343,125	78,443	31	7
1952–53	812,825	87,365	74	8
1953–54	446,340	—	41	—
1954–55	326,275	153,340	30	14
1955–56	200,324	327,419	18	30
1956–57	66,150	616,000	6	56

[1] Fiscal year July 1 to June 3.
[2] Carp taken by seines; bullheads by hoopnets only prior to 1956.
* Average for 2-year period.

The seines used are about 4000 feet long and they are usually set beneath the ice so they can be hauled or "walked" down the central trough of the lake. In the winter of 1947-48 the usual area seined per haul ranged from 320 to 400 acres. In the 11 years of the 1945-57 period when seining was done, the number of hauls per year has ranged from 21 to 48 (Table 3).

The central bag of the seine has webbing of 1¼-inch bar measure (2½-inch extension measure) and attached to it on each side is 300 feet of 1½-inch webbing, then 1200 feet of 2-inch mesh and, on the shore end, 250 feet of 2½-inch (bar-measure) webbing. The hoopnets fished in Lake Traverse have four hoops about 4 feet in diameter and a center lead 25 feet long. The tarred webbing is 1-inch bar measure and the twine not smaller than 18 gauge. Hoopnets are usually set for several

lays; the length of time depending on whether he fish are running into the nets.

Bullheads captured in removal operations re graded as follows: Grade No. 1—less than 2 live fish, or 2 to 4 dressed fish to a pound; Grade No. 2—3 to 5 live fish, or 5 to 10 dressed fish to a pound; and Grade No. 3—6 or more live fish, or 12 or more dressed fish o a pound. Bullheads when dressed (heads, ntrails and skin removed) are about half the ound or live weight. An experimental series f 272 No. 1 fish dressed out to 51 percent f the round weight in January, 1958. These ish in the round had an average total length f 10.3 inches, average weight of 0.59 pounds

TABLE 3.—*Average catch of fish in seines, Lake Traverse 1945-1958*

Year[1]	Carp lbs. per haul[2]	Numbers of game fish per haul: Walleyes	N. Pike	Crappies	Largemouth bass	Channel catfish
945–46	—	—	—	—	—	
946–47	25,896 (31)	47	19	251	0	0
947–48	—	—	—	—	—	
948–49	26,163 (41)	6	13	667	—	0
949–50	8,766 (48)	9	29	3,663	0	0
950–51	57,726 (36)	126	59	2,074	2	1
951–52	12,708 (27)	14	137	2,824	1	1
952–53	18,903 (43)	20	29	2,451	2	3
953–54	10,627 (42)	100	119	1,451	1	13
954–55	11,653 (28)	192	139	2,125	2	2
955–56	5,008 (40)	61	114	21,174	4	3
956–57	3,150 (21)	51	44	31,657	0	4
957–58	509 (29)	*—	*—	84,000	*—	*—

[1] Fiscal year, July 1 - June 30.
[2] Number of seine hauls shown in parentheses.
* Data incomplete.

nd a condition factor between 50 and 55 condition factors in the low 40's indicate nin or "scrawny" bullheads). These No. 1 sh, as determined from vertebral annuli, were and 4 years old.

Catch data for bullheads taken in 13,480 oopnet lifts from Traverse during 1956-58 ndicate that the population was dominated y a single size-class (and presumably year-lass). In September 1956 the hoopnet catches ere graded as mostly No. 3 fish. As fishing rogressed the grade rose to No. 2 and No. 3 sh, then to No. 2, and finally in Jaunary 1958, he catch was mostly of No. 1 bullheads. Average weight of catch per pocket declined as he size of fish increased as follows: August-December 1956—146 pounds; January-June 957—54 pounds; September-December 1957 —32 pounds; and Jaunary-February 1958—31 ounds per pocket.

By January 1958 the bullhead catch was mostly of No. 1 fish weighing about a half pound, and, because these fish were highly desirable for angling, the netting was terminated in mid-February. No. 1 and No. 2 bullheads taken by netting are usually dressed for sale as human food, but often bullheads of this size, as well as some No. 3 fish, are shipped alive by tank truck to southern waters where they are stocked for put-and-take angling.

Catch of bullheads per hoopnet pocket was higher in 1956-58 than in 1950-53; mean catches for these periods being 65 pounds and 25.3 pounds, respectively.

FISH STOCKING

In all years from 1948 through 1955 some game fish were stocked in Lake Traverse (Table 4). Most frequently stockings were of walleye fry and fingerlings, northern pike fry, and rescued adult crappies. Fry and fingerling stocking in Lake Traverse, and similar shallow lakes subject to low winter oxygen levels, is a considered risk that is often taken. In such waters game fish grow rapidly and, if winter kill does not occur, production of walleyes and northern pike weighing ½ to 1 pound the second summer after fry stocking is common.

In five of the years, 1949, 1950, 1951, 1952, and 1953, adult crappies were planted in amounts ranging from 1000 to 20,341 fish. Most of these were rescued fish from adjacent Mud Lake which frequently winterkills. Lesser numbers of bullheads, yellow perch and other species were also transferred to Lake Traverse. It seems obvious from a consideration of take of crappies per seine haul (Table 4) that these transfers had little effect on the total crappie population of the lake.

CHANGES IN THE FISH POPULATION

Several extensive changes in the fish population of Lake Traverse occurred between 1945 and 1958. Some probably were the result of management, some brought about by changes in natural conditions in the lake, and some likely attributable to both.

Walleyes

Walleye fry were stocked in Lake Traverse every year from 1948 through 1957 (Table 4). The stockings ranged from 25 to 254 fry

per acre in the different years. In addition, pond-reared fingerlings were planted in four of the years at rates ranging from 1.0 to 2.5 per acre, and in one year (1951) 1,000 adult walleyes were transferred to the lake.

Past fish kills on Minnesota and South Dakota lakes indicate that the walleye is sensitive to low oxygen levels. It has been observed that bullheads are somewhat predaceous on small fish. The data are, therefore, arranged in Table 4 to show stocking, subsequent take of walleyes per seine haul, minimal recorded winter oxygen conditions, and general abundance of bullheads during the fishing year when the walleyes were planted. Removal of bullheads per acre during any year is taken as an index of their abundance. Chronology of the series of events considered is: (1) oxygen conditions in the winter prior to stocking; (2) stocking of fry in May or of fingerlings in late summer or early fall; (3) bullhead removal by hoopnets in the year of stocking; (4) oxygen conditions the winter following planting; and (5) average take of walleyes per seine haul during the fishing year 14 to 26 months after stocking.

Largest walleye catches were made in three years when winters of plentiful oxygen (5.0 p.p.m. or more) occurred between stocking and seining. In two of these high-catch years (1949 and 1952) stocking was preceded by winters with low oxygen levels (some reading below 5.0 p.p.m.). This may have eliminated some game fish and reduced competition for the stocked fish. The year of highest walleye catch (1953) followed two successive winters of high oxygen levels and probably represents cumulative survival for two years. Stockings of fry and fingerlings appear to be equally susceptible to low oxygen concentrations. In this evaluation oxygen levels of 2.0 to 5.0 p.p.m. seem to be about as harmful to walleyes as levels below 2.0 p.p.m. Good survival of walleyes may well require the 5.0 p.p.m. dissolved oxygen, the level proposed as a criterion of game-fish waters by Ellis, Westfall and Ellis (1948).

In considering the Lake Traverse data, however, it should be emphasized that: (1) critical oxygen levels may have been missed in sampling; (2) that tolerable local conditions sometimes exist in the presence of generally intolerable conditions; and (3) that in Lake Traverse some fish can move into springs. These factors may account for the fairly good take of walleyes following the 1956 winter of low oxygen levels (0.3 to 1.3 p.p.m.).

Because both fry and fingerlings were planted in many of the years, and because data are lacking on the angling catch, precise quantitative evaluation of survival of planted fish is not possible. It might be noted, however, that a planting of 206 fry and 1.0 fingerling per acre in 1949 was followed by a seining catch of 126 fish per haul and a much smaller planting of 25 fry and 2.5 fingerlings per acre

TABLE 4.—*Walleye, northern pike and crappie plantings in Lake Traverse and number of fish taken in seine catches 14 to 26 months later, as related to oxygen levels the winters before and after stocking, and to bullhead catch in year of stocking*

Year of stocking[1]	Oxygen level[2]		Bullhead catch[3]	Walleyes		Northern Pike		Crappies (rescued)	
	Winter before stocking	Winter after stocking		Stocking[5] N. per A.	Mean take per haul[4]	Stocking[5] N. per A.	Mean take per haul[4]	Stocking[5] N. per A.	Mean take per haul[4]
1948	C	L	no fishing	46f.	9	86f. 1.3A	29	0	667
1949	L	H	high	206f. 1.0fg.	126	264f.	59	0.1A	3,663
1950	H	L	moderate	44f. 2.9fg.	14	0.4A	137	0.1A	2,074
1951	L	L to H	low	24f. 0.1A	20	203f.	29	0.4A	2,824
1952	L to H	H	low	25f. 2.5fg.	100	0	119	1.5A	2,451
1953	H	H	low	173f.	192	0	139	0.1A	1,451
1954	H	L to H	no fishing	254f.	61	0	114	0	2,125
1955	L to H	C	moderate	218f. 1.6fg.	51	0	44	0	21,174
1956	C	*no data	high	181f. 5.6fg.	0	0	0	0	31,657

[1] Fry are stocked in May, fingerlings in summer, rescued fish in fall and winter.
[2] C—critical; L—low; H—high. See text for explanation.
[3] Catch summer after stocking; see text.
[4] Numbers of fish.
[5] f—fry; fg—fingerlings; a—adult.
* Presumably high, little snow on ice.

by a take of 100 fish per haul—both after favorable winters.

If the mortality between fry and fingerling stage is considered to be similar to that in rearing ponds (about 90 percent) and the average size of seine haul taken as 350 acres it would appear that survival of fry to catchable-sized walleyes in Traverse may well be in the general magnitude of one catchable fish from 100 to 500 fry. This estimated survival rate might well be higher if the number of fish taken by angling were known.

Walleyes are not known to spawn in Lake Traverse, and it is likely that each fry stocking after a winter of low oxygen essentially represents an introduction; but an introduction into water where competition from other predaceous fishes is considerable. It appears that stocking in Lake Traverse has produced walleye populations—albeit temporary—and, according to local report, has sometimes produced good walleye fishing.

It seems unlikely from the scanty evidence in Table 4 that variation in numbers of bullheads has been an important factor in the survival of stocked walleyes in Lake Traverse. The walleye catch was high in the two years when favorable winter oxygen conditions followed stocking (1949, and 1952) although the bullhead take was "high" in the latter year and "low" in the former.

Northern Pike

As for walleyes, the data for northern pike (Table 4) show a high take of fish in the seines when stocking or spawning years were followed by good winter oxygen conditions (1952 and 1953). Catches were also good, however, after spawning-year 1950 in which stocking, and probably natural spawning, was followed by low winter oxygen (minimum recorded range 0.9—2.7 p.p.m.), and again after 1954 which was followed by a winter of "spotty" oxygen conditions (minimum of 1.6 to 11.6 p.p.m.). At no time were northern pike really scarce. The tolerance of pike to low oxygen concentrations in Lake Traverse is in agreement with the findings of Cooper and Washburn (1949) on Michigan lakes. The greater tolerance of northern pike than walleyes to low winter oxygen levels might have been expected in view of the habitats frequented by the two species; walleyes are native to larger less fertile lakes and northern pike range into smaller and more fertile waters that often have a high oxygen demand in winter. Four of the five years of highest seining catch for northern pike followed years in which no pike were stocked. It is evident that even with fairly low winter oxygen levels pike have maintained themselves in Lake Traverse without artificial stocking.

Crappies, carp and bullheads

A striking feature of the Lake Traverse data (Tables 2 and 4) is the increase in the crappie catch that accompanied the decrease in the carp catch. Prior to 1953, average catch of crappies per seine haul fluctuated irregularly between 1000 and 400 fish. Between 1953 and 1954 the catch per haul rose about 10-fold (from 2,125 to 21,174 fish) and then rose further to 31,657 fish per haul in 1955. This upward trend of the crappie population has continued and during the winter of 1957-58 the average take of seines was 14 tons (estimated at 84,000 fish) of crappies per haul (range 5 to 30 tons per haul). This catch represents a standing crop of about 70 pounds per acre of fairly large, but thin, crappies (3 to the pound) for the 29 areas seined. At this time it was necessary to put escape slots in the hoopnets fished for bullheads to keep them from being rapidly filled with crappies.

During the 1945-57 period average take of carp per seine haul reached a high point of 57,726 pounds in 1950-51. In following years catch of carp per haul declined in a fairly regular fashion until 1956-57 when the average catch was 3,150 pounds per haul—an 18-fold decrease. The downward trend in the carp catch continued and in the winter of 1957-58 few carp (509 pounds per haul) were taken. Beginning in 1956 it became necessary to include bullheads in the seining contract to make the rough fish removal economically feasible. Take of bullheads has fluctuated during the 14 years ranging from a low of 7 pounds per acre by hoopnets in 1951-52 to a high catch of 56 pounds per acre in 1956-57 when they were taken both with hoopnets and seines. As already pointed out, catch of bullheads per hoopnet pocket more than doubled during this same period.

It is of great practical importance to know whether the increase in crappies and bullheads was made possible by the decline in carp. Cause and effect can not be proven but it seems likely that these population trends are related. A suggested mechanism is that marked reduction of numbers of adult carp resulted in greater

spawning success of crappies and bullheads and the increased numbers of these species, together with walleyes and northern pike, increased predation on the young carp. It is pertinent that, although the take of carp declined drastically between 1950 and 1958, the size carp taken in the seines remained about the same; No. 1 carp, weighing 4 to 7 pounds making up most of the catch. This indicates that carp were reproducing but that survival of the young carp was low.[3]

Other species

Several attempts were made to establish a bluegill population in Lake Traverse during 1945-1957. Plantings were as follows: 1948, 200 adults; 1949, 1,350 adults and 3,500 fingerlings; and in 1950, 1000 adults. "Sunfish" (presumably bluegills) ranged from 0 in 1951-52 to 82 fish per haul in 1953-54. Again highest catches followed winters of good oxygen conditions.

Several plantings of largemouth bass have also been made but only a few bass have been taken in the seines (Table 3). Channel catfish—locally called "fiddlers"—were planted as follows: 1950, 2,250 fingerlings; 1953, 2000 fingerlings; 1954, 2,500 fingerlings; and in 1955, 1,500 fingerlings. Seining catches during the 1950-57 period have been low (1 to 13 per haul) with year of highest catch (1953-54) the one preceded by two winters of good oxygen conditions. Catch of yellow perch was highest in 1952-53 when 973 per haul were taken. The year was preceded by "spotty" low-to-high oxygen levels. In all other years fewer than 350 perch per haul were taken. Catch of white suckers was usually between 300 and 1000 per haul with no catch trend evident other than the lowest catch (16 per haul in 1948-49) followed a winter when dissolved oxygen in one series of analyses, was below 1.1 p.p.m. and dead fish were noted in the seines.

DISCUSSION

The increase of game fish in Lake Traverse following intensive removal of rough fish is similar to that reported for East Okoboji Lake in Iowa by Rose and Moen (1953) and for Bass Lake in Indiana by Gottschalk and Ricker (1941). In all three lakes the rough fish population was greatly reduced, and in Traverse and East Okoboji lakes "overfishing" of rough fish by seining continued over a period of years. In Lake Wingra, Wisconsin, which was intensively seined for four years, Neess, Helm, and Threinen found no reproduction of carp, as judged from appearance of new year-classes in the hauls in subsequent years. It has frequently been found in the midwest that light or sporadic seining for carp and other rough fish results in little more than cropping and often exchange of larger rough fish for smaller fish of the same species.

The Traverse data suggest intensive removal of carp coupled with an increasing population of predaceous fishes kept large year classes of carp from being established. The diet of black crappies often includes fish (Reid 1950; Van Engle 1951) and brown bullheads are somewhat piscivorous (Fornay, 1955; Eddy and Surber, 1953, p. 156).

Fluctuating water levels, as noted by Shields (1958), can limit carp reproduction but seems not to have been a factor in Lake Traverse. Water levels during the last two weeks of June, when carp usually spawn, have fluctuated less than 6 inches during the 1951-58 period. The exact nature of the competition between game and rough fish can be expected to vary from lake to lake and with the species concerned but includes competition for food and space, predation, and probably more subtle relationships such as the "repressive factor" (probably chemical) noted by Swingle (1956). More experimental work such as that of Mraz and Cooper (1957) is needed.

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Salmon Populations and Bottom Fauna in the Wenatchee River, Washington

C. P. RUGGLES[1]
Department of Natural Resources, Fisheries Branch, Saskatoon, Saskatchewan.

ABSTRACT

The standing crop of bottom fauna in the Wenatchee River, Washington, and its tributary Nason Creek declined from an average of 233 animals per square foot in the fall of 1940, to an average of 50 animals per square foot in the falls of 1955 and 1956. Average volumes declined from 2.7 cubic centimeters per square foot in 1940 to 0.3 and 0.4 cubic centimeters per square foot in 1955 and 1956. During this same interval the populations of chinook salmon and steelhead trout in the stream had increased greatly and the sockeye run had increased at least 7-fold. Since sockeye young migrate down the Wenatchee River after spending their juvenile period in Lake Wenatchee, it seems likely that the increase in salmonids in the stream has been an important factor in reducing the bottom fauna crop.

INTRODUCTION

It has been observed by several fishery workers that large fish populations may reduce the standing crop of bottom fauna in ponds and lakes. Larkin *et al.* (1950) show the effect of Kamloops trout predation on the fresh-water amphipod, *Gammarus*, in Paul Lake, British Columbia. Hayne and Ball (1956) demonstrated that predation by fish could substantially lower the standing crop of bottom fauna in two ponds in southern Michigan. Reimers (1958) shows the effect of eastern brook trout predation on the bottom fauna of a high mountain lake in California. Data gathered during a pre-impoundment survey of the Wenatchee River System are here presented, suggesting that this same phenomenon may also occur in salmonid streams.

Lake Wenatchee, in the Cascade Mountains of western Washington, is one of the few remaining rearing areas for sockeye salmon (*Oncorhynchus nerka*) in the Columbia River System. The lake drains into the Columbia River by way of the Wenatchee River (Figure 1). The Wenatchee River falls 1,230 feet from its origin at Lake Wenatchee to its confluence with the Columbia River 55 river miles downstream. It has a mean annual flow of approximately 2,900 c.f.s. Principal tributaries below Lake Wenatchee are Nason Creek, Chiwawa River and Icicle Creek. The river basin in its upper 25 miles is mountainous and heavily forested. In its lower portions the stream flows through rolling foothills where orchards occupy the valleys. Flow is controlled principally by snow melt in the mountains.

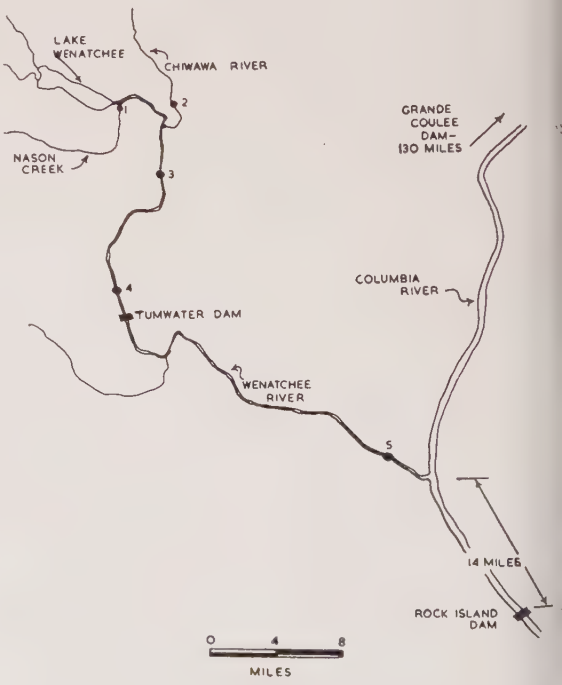

FIGURE 1.—The Wenatchee River showing sampling stations and locations of Rock Island and Tumwater Dams.

[1]Present address is Canadian Department of Fisheries, 1110 West Georgia Street, Vancouver 5, B. C.

BOTTOM FAUNA PRODUCTION

In 1940 the U. S. Fish and Wildlife Service onducted an extensive study of the fish food rganisms in the Wenatchee River System and hese data are on file in the office of the Fish nd Wildlife Service, Seattle, Washington. One f the objectives of the survey was to deter- nine whether these streams produced sufficient ood to supply the increase in the salmon pop- lation expected as a result of establishing in his area salmon runs native to the region bove Grand Coulee Dam. Bottom organisms vere collected from August through Novem- er. No seasonal changes in numerical abund- nce were observed. The average count ob- ained in 68 quantitative samples was 223 ani- nals per square foot; the average volume was 2.7 cubic centimeters per square foot. These ata justify a Grade I productivity rating (Madsen, 1935).

In 1955 and 1956 the bottom fauna popu- ation of the Wenatchee River was studied as art of a pre-impoundment survey of this area. The decrease in the standing crop of bottom rganisms found in 1955 and 1956 as com- ared to 1940 (Table 1) represents a drop in

TABLE 1.—*Quantity of animals per square foot of sampled area in the Wenatchee River System during the period August-September of 1940, 1955 and 1956.*

Year	1940	1955	*1956
Number of samples	68	30	41
Average number per sample	233	31	69
Average volume (cubic centimeters)	2.6	0.3	0.3
Greatest number	1,096	146	192
Least number	26	4	2
Greatest volume (cubic centimeters)	12.3	0.9	1.8
Least volume (cubic centimeters)	0.1	trace	trace
Percent by number:			
Caddisflies	33	15	13
Mayflies	36	57	68
Stoneflies	14	9	9.5
Aquatic Diptera	11	12	7.4
Other Organisms	6	6.8	2.1

*In 1956 three of the sampling locations were changed so that the most productive areas available could be sampled.

ood grade from "rich" to "poor." The increase f bottom organisms in 1956 over 1955 is due ainly to the changing of three of the sam- ling locations. An attempt was made in 1956 sample only the most productive areas in e general vicinity of the sampling station. quantitative summary of all square-foot mples taken during 1955 and 1956 is given Table 2.

The decrease in the standing crop of bottom organisms may be interpreted as evidence of (a) a decline in the basic productivity of the stream; (b) the destruction of the bottom fauna through some change in the physical environment; or (c) an increased use of the bottom fauna by fishes.

It is unlikely that the basic productivity of the Wenatchee River System has altered a great deal during the past fifteen years. The greater part of the Wenatchee River Basin is within the Wenatchee National Forest, and has enjoyed protection from industrial influences which might affect its productivity. A limited amount of chemical data was collected during the 1940 fish-food study. These data have been compared with similar data collected in 1955 and 1956. The comparison indicated that the water quality had not been altered during the time interval.

Various sprays for pest control used in the orchards in the lower Wenatchee valley may limit the numbers of aquatic organisms in that region, but this explanation cannot account for the decrease in bottom fauna in the area of the upper Wenatchee, Nason Creek, and Chiwawa River, which is lacking in orchards. The U. S. Forest Service has not conducted extensive insect control programs that could account for the observed decrease.

Runoff is regarded as an important factor in controlling the quantity of bottom organisms in streams. Severe floods dislodge and grind up the bottom organisms as the water velocity scours the stream bottom. The Wenatchee River system has always experienced severe fluctuations in flow; however, the period from August to November is usually the most stable period in this respect and is therefore the most favorable season for the study of bottom organisms.

Stream flow on the Wenatchee River at the town of Peshastin in the four years 1939, 1940, 1955 and 1956 is shown in Figure 2. Similar seasonal patterns are observed in Nason Creek and the Chiwawa River. It may be noted that the peak flows occur in May and June; relatively low flows occur in August, September and October. The flow increases somewhat in November due to autumn rains. In general, this seasonal pattern of flow is similar for all four years. The total flow is higher in 1955 and 1956 than in the years 1939 and 1940, but is seem unlikely that the change in total flow could account for the observed decline

in stream bottom fauna. The great increase in flow in 1955 and 1956 occurred in the months of May and June but the observations of bottom fauna used for comparison were made from two to five months later. There is evidence to suggest that the bottom fauna of streams recovers rather quickly after flooding. Lake (1957) working on Australian streams found that floods caused serious depletion of the bottom fauna, but that repopulation occurred within one month to levels as high or higher than those found prior to flooding. Rapid repopulation of stream bottom fauna is also reported by Moffett (1936) and Müller (1953).

TABLE 2.—*Numbers and volume of fish-food organisms in square-foot river bottom samples, Wenatchee River, 1955-56*

Date	[1]Station Number 1		Station Number 2		[1]Station Number 3		Station Number 4		Station Number 5	
	Numbers	Volume (cubic centimeters)	Numbers	Volume (cubic centimeters)	Numbers	Volume (cubic centimeters)	Numbers	Volume (cubic centimeters)	Numbers	Volume (cubic centimeters)
1955:										
Aug. 8.....	15	0.2	7	0.05	10	0.1	4	0.5	17	0.1
Aug. 22.....	7	0.1	37	0.1	8	0.3	4	0.2	68	0.55
Sept. 7.....	33	0.1	86	0.8	17	0.5	9	0.1	28	0.2
Sept. 20.....	16	0.1	94	0.9	41	0.4	18	0.1	41	0.1
Oct. 22.....	10	0.05	123	0.9	29	0.3	8	0.05	8	0.05
Nov. 25.....	—	—	146	0.7	—	—	—	—	28	0.3
Dec. 21.....	—	—	—	—	—	—	—	—	18	0.2
Average.....	16.2	0.11	82.2	0.58	21.0	0.32	8.6	0.19	29.7	0.21
1956:										
May 17.....	1	trace	0	0.0	—	—	—	—	—	—
July 3.....	65	0.3	57	0.3	53	0.25	—	—	59	0.2
July 17.....	35	0.15	40	0.45	33	0.25	49	1.3	46	0.3
July 31.....	33	0.2	48	0.5	37	0.4	24	0.55	28	0.1
Aug. 17.....	58	0.1	37	0.2	34	0.2	36	0.4	28	0.1
Aug. 28.....	94	0.4	81	0.6	60	0.4	84	1.0	26	0.1
Sept. 11.....	63	0.3	89	0.2	49	0.45	79	0.5	21	0.1
Sept. 25.....	118	0.2	125	0.2	89	0.2	131	0.5	92	0.2
Oct. 9.....	92	0.25	112	0.4	89	0.2	118	0.6	99	0.3
Oct. 23.....	134	0.6	149	0.7	36	0.4	41	0.4	2	trace
Nov. 6.....	56	0.2	171	1.8	64	0.4	68	0.6	18	trace
Nov. 20.....	—	—	192	0.9	—	—	140	1.1	21	trace
Dec. 18.....	—	—	37	0.3	—	—	14	trace	3	trace
Average.....	68.1	0.25	81.5	0.46	54.5	0.32	71.4	0.63	35.9	0.14

[1] Sampling station moved in 1956 to riffle area.

FISH RUNS IN THE WENATCHEE RIVER

Since 1940 the population of the salmonoid fishes in this area, as judged from counts of spawning adults at Rock Island dam and Tumwater dam, has risen sharply. This increase is probably a result of a more intense and efficient management of the salmon and steelhead populations, including screening of irrigation diversions, construction of fishways, hatchery operations and closed seasons. A major factor responsible for the increase in salmon and steelhead in this area was the relocating of runs native to the upper Columbia River System into the Wenatchee River System after the building of Grand Coulee Dam.

Although no comparison of the actual populations of young salmonoids in the Wenatchee River system for 1940, 1955 and 1956 can be made, some measure of their relative abundance may be obtained by comparing the spawning escapement of their parents. For the chinook salmon the runs the year before will determine, in part at least, the number of young produced. The steelhead may spend two years foraging in fresh water and the majority of sockeye will not enter the streams for their seaward migration until their second year of life.

Counts of adult migrants at Rock Island Dam on the Columbia River about 14 miles below the Wenatchee River have been made throughout the period in question. During some years counts have also been made at the Tumwater Dam on the Wenatchee River. Recent counts suggest that a fixed proportion of the salmon and steelhead reaching Rock Island Dam proceed up the Wenatchee River. This

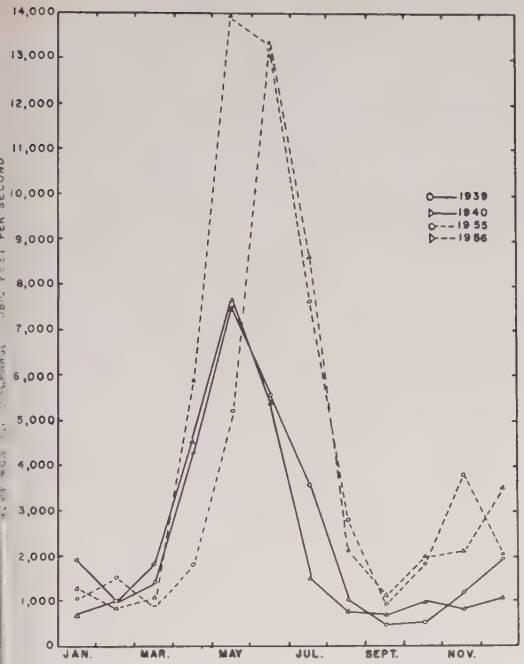

FIGURE 2. Monthly stream flows of the Wenatchee iver in the years 1939, 1940, 1955 and 1956 re-rded at Peshastin, Washington.

ercentage is higher now than during the peri-d prior to completion of Grand Coulee Dam. rom counts made in 1954, 1955 and 1956 Rock Island and at Tumwater Canyon on e Wenatchee River an estimate of the per-ntages of the various species reaching Rock land Dam and proceeding to the Wenatchee stem can be made. A similar estimate for the ars 1935, 1936 and 1937 was made by the Vashington State Department of Fisheries. he estimates of the percentage of salmon and elhead which reach Rock Island Dam and roceed up the Wenatchee are as follows:

	1954, 55 and 56	1935, 36 and 37
hinook	34%	1%
eelhead	21%	1%
ckeye	30%	0.2% to 6.4%

A marked increase in the salmonoid popu-ion of the Wenatchee River is shown by mparing the counts at Rock Island Dam on e Columbia River for the years 1938 and 39 and the years 1953, 1954 and 1955 Table 3). These data suggest that a great rease in the salmon, and steelhead popula-n in the Wenatchee River System has taken ce since the completion of Grand Coulee m in 1939.

The increase in the fish population of the enatchee River system can be shown only for the salmon and steelhead. Coarse fish such as chubs, squawfish, dace, shiners, suckers, whitefish and sculpins feed principally on the aquatic insect fauna found in these streams, and it is not believed that these fish have declined in numbers. Chapman and Quistorff (1938) found relatively few dolly varden trout, cutthroat trout, and eastern brook trout in the Wenatchee River during their study. Probably some increase has occurred in the populations of these fishes due to the recent practice of planting legal size fish in place of greater numbers of small fish which are known to suffer high mortalities shortly after their introduction.

FISH AND BOTTOM FAUNA RELATIONSHIP.

Chapman and Quistorff (*loc. cit.*) found that stream bottom fauna made up more than 70 percent of the salmon and steelhead diet in the Wenatchee River system. They also found that the young sockeye salmon, although strictly plankton feeders in Lake Wenatchee, feed heavily on stream bottom organisms during their migration to the ocean. The probability that the large salmon and steelhead populations are at least partly responsible for the low standing crop of bottom fauna should now be considered.

A comparison has been made between the amount of bottom fauna in the Wenatchee River System and estimates of the population of spawning salmon and steelhead for the two years previous to the period in which bottom samples were collected (Figure 3). The fish population in 1938 and 1939 has been estimated by assuming that 6 percent of the migrating salmonids reaching Rock Island Dam proceeded up the Wenatchee System. (Actual count made from 1935 to 1937 indicated that from 1 to 6.4 percent of the fish reaching

TABLE 3.—*Counts of salmon and steelhead at Rock Island Dam, for the periods 1938 - 1942 and 1951 - 1955.*

[Data from U. S. Fish and Wildlife Service Records, Seattle.]

Year	Chinook	Steelhead	Sockeye	Total
1938	5,803	2,400	17,123	*25,326
1939	9,206	5,427	19,591	*34,224
1940	9,492	5,550	26,894	41,936
1941	2,571	3,561	949	7,078
1942	6,814	3,586	16,282	26,682
1951	18,752	3,121	101,826	123,699
1952	20,121	2,883	114,349	137,353
1953	31,080	4,001	151,747	**186,823
1954	33,283	5,407	91,234	**129,924
1955	25,712	3,347	154,706	**183,765

*Approximately 6 percent of these fish proceeded up the Wenatchee River.
**Approximately 25 percent of these fish proceeded up the Wenatchee River.

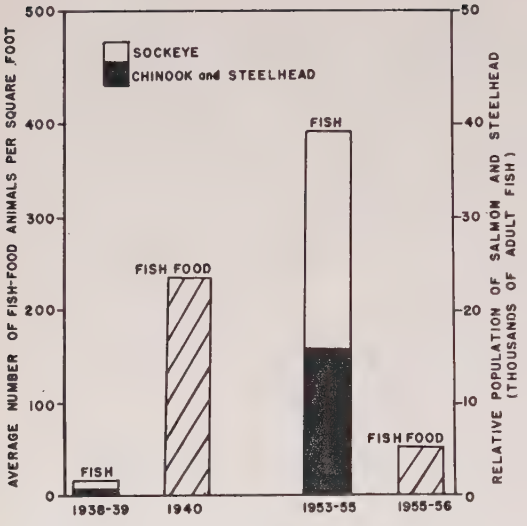

FIGURE 3. The relation between observed numbers of fish-food organisms in 1940 and 1955-56, and the estimated numbers of adult salmon and steelhead migrants in the Wenatchee River in the years preceding these observations.

Rock Island Dam migrated up the Wenatchee River.) During the period 1953-1955, approximately 25 percent of the Rock Island run migrated up the Wenatchee River. From these data it appears that the fish population has increased more than 10-fold since 1939. During the same period, the bottom fauna has decreased to about one-fifth of the original density. This inverse relationship between the numbers of young salmon and steelhead and their main food supply, suggests strongly that the reduction in fish-food organisms is due to the grazing activity of a much larger fish population.

In addition to the reduction of fish-food organisms, there has been a change in the composition of the aquatic insect population. There is a considerably larger percentage of mayfly larvae in the samples of 1955 and 1956 than in 1940. From Chapman and Quistorff's work (*loc. cit.*) one can evaluate the relative contribution of the various types of aquatic food organisms to the salmon and steelhead diets. The percentage contributed by each group is as follows: caddisflies 1.1; mayflies 0.7; stoneflies 2.8; aquatic Diptera 67.0; others 28.4. These data point out the low grazing activity of salmon and steelhead young on the mayfly population. This may be the explanation for the significant increase in the relative percentage of mayflies in the bottom fauna also evidence that the fish population is exerting pressure on the bottom organisms.

ACKNOWLEDGEMENTS

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Growth of the Redeye Bass in Chipola River, Florida

JOHN W. PARSONS[1] AND EDWARD CRITTENDEN[2]

The black bass fishery on the 30-mile segment of the Chipola River between Marianna and Clarksville, Florida, has been unique. In this relatively fast-flowing stream, fishermen caught brightly colored bass weighing up to 6 pounds—a kind known from no other waters in Florida. Never positively identified, the fish were called "shoal" bass by local fishermen. Some were taken in 1957 by biologists of the Florida Game and Fresh Water Fish Commission who conducted fish-population studies on the Chipola River[3]. The fish known as "shoal" bass were identified as redeye bass, *Micropterus coosae,* by Dr. Reeve Bailey, Curator of Fishes, University Museum, University of Michigan.

The Chipola River originates in Houston County, Alabama, and flows approximately 100 miles in a southerly direction to its confluence with the Apalachicola River in Gulf County, Florida. The 30-mile stream segment where redeye bass are found has many fast-flowing shoals, and the pools are large and deep. Stream width varies from 75 to 150 feet. Normal summer water flow is about 300 cubic feet per second. The bottom is principally of sand, rubble, and limestone outcropping. Much of the stream flow comes from large springs, and the stream is usually clear (turbidity less than 5 p.p.m.). Annual water temperatures usually range from about 50° to 75° F. On July 19, 1957, near Marianna, water temperature was 70° F., pH was 8.7, and total alkalinity was 75 p.p.m.

Thirty-five species of fish have been identified from the Chipola River. Other than the redeye bass, principal species taken in the survey were: largemouth bass, *Micropterus salmoides;* warmouth, *Chaenobryttus coronarius;* bluegill, *Lepomis macrochirus;* spotted sunfish, *Lepomis punctatus;* redbreast sunfish, *Lepomis auritus;* southern rock bass, *Ambloplites rupestris ariommus;* redfin pickerel, *Esox americanus;* yellow bullhead, *Ictalurus natalis;* channel catfish, *Ictalurus punctatus;* flat bullhead, *Ictalurus platycephalus;* speckled madtom, *Noturus leptacanthus;* spotted sucker, *Minytrema melanops;* blacktail shiner, *Notropis venustus;* Alabama shad, *Alosa alabamae.* The carp, *Cyprinus carpio,* and striped mullet, *Mugil cephalus,* have been observed since.

Twenty-eight redeye bass were taken with the use of rotenone from Chipola River near the mouth of Dry Creek in Jackson County in June and October 1957. Lengths and weights were taken from 21 of these fish and scales from 10. These fish are now preserved at the University of Florida at Gainesville.

Eleven redeye bass were taken by angling in January 1957 by Edward Crittenden. Lengths, weights, and scales were taken from the specimens now preserved at the Museum, University of Michigan. All scales were collected below the lateral line posterior to the tip of the extended pectoral fin.

Since high scale regeneration prohibits determination of body-scale regressions, lengths at each annulus were computed by the direct-proportion method which may partly account for apparent growth discrepancies in the older fish. Annuli were very distinct; false annuli were not apparent.

Seventy-six percent of the scales of the redeye bass from the Chipola River were regenerated. Since 82 percent of the redeye bass scales examined from Sheeds Creek, Tennessee, (Parsons, 1954) and 61 percent from Spring Creek, Tennessee[4], were also regenerated, the deciduous nature of scales of redeye bass appears widespread. Regeneration occurs least frequently on the two rows of scales posterior to the base of the pectoral fins on the redeye bass from the Chipola River. However, these scales are irregularly shaped.

The average weights for ½-inch length groups are shown in Table 1.

The largest fish aged from the Chipola River was 5 years old and 15.1 inches long and weighed 1 pound, 12.2 ounces. Two larger fish preserved for taxonomic purposes and not aged were 16.5 and 19.0 inches long and weighed 2.5 and 4.5 pounds, respectively.

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[1]Bureau of Commercial Fisheries, U. S. Fish and Wildlife Service, Ann Arbor, Michigan.

[2]Florida Game and Fresh Water Fish Commission, Panama City, Florida.

[3]Conducted as part of a Dingell-Johnson lake and stream survey project.

[4]Typewritten report, Tennessee Game and Fish Commission.

TABLE 1.—*Total lengths (inches) and weights (ounces) of 32 redeye bass, Chipola River, Florida, 1956 and 1957*

Length	Number of fish	Weight	
		Average	Range
7.5– 7.9	2	3.1	2.7– 3.6
8.0– 8.4	4	4.4	3.8– 5.0
10.5–10.9	3	8.7	8.0– 9.0
11.0–11.4	2	9.5	9.0 10.0
11.5–11.9	1	13.0	—
12.0–12.4	3	14.1	13.0–15.0
12.5–12.9	6	15.8	14.1–17.0
13.0–13.4	1	17.0	—
13.5–13.9	1	21.0	—
14.0–14.4	2	25.0	23.0–27.0
14.5–14.9	4	28.2	25.0 30.0
15.0–15.4	1	28.2	—
15.5–15.9	—	—	—
16.0–16.4	1	40.0	—
16.5–16.9	1	40.0	—

TABLE 2.—*Calculated growth (inches) of 21 redeye bass, Chipola River, Florida, 1956-1957*

Number of fish	Age group	Total length at end of year				
		1	2	3	4	5
1	I	4.1	—	—	—	—
8	II	4.0	8.1	—	—	—
7	III	4.3	8.4	12.2	—	—
1	IV	3.0	8.6	12.6	15.5	—
4	V	2.9	7.2	10.0	12.4	13.8
Average total length		3.8	8.1	11.5	13.0	13.8
Average annual increments		3.8	4.3	3.3	2.5	1.4
Sum of increments		3.8	8.1	11.4	13.9	15.3

Growth of the redeye bass was greatest (4.3 inches) during the second and least (1.5 inches) during the fifth year of life (Table 2). Fish reached angling size (10 inches) in the third summer of growth (Age-group II).

The growth of the redeye bass from the Chipola River is much greater than that reported from Sheeds Creek (Parsons, 1954) and Spring Creek, Tennessee[4]. At the end of 3 years of life, redeye bass from Chipola River are 1.2 inches longer than 10-year-old fish from Sheeds Creek, and nearly twice the length of 3-year fish from Spring Creek (Table 3).

The fast growth of the redeye bass in Chipola River is postulated to be a result of a long annual growing season, large stream habitat, clear water, and an abundance of productive shoals.

Other large redeye bass have been reported in the Apalachicola River system. One, taken with the use of rotenone on October 10, 1953, from Little Uchee Creek, a tributary to the Chattahoochie River in Alabama (Dendy, 1954), was 19.0 inches long, weighed 3 pounds 10 ounces, and was 10 years old. The largest redeye bass aged by biologists was caught by a fisherman below Goat Rock Dam on the Chattahoochie River, Georgia and Alabama, on April 14, 1958. The fish, according to Jack Dendy, Alabama Polytechnic Institute, (by letter) was 18.9 inches long, weighed 4.4 pounds and was 6 years old.

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TABLE 3.—*Comparison of growth of redeye bass from Chipola River, Florida, and Sheeds and Spring Creeks, Tennessee*

Stream	Total length (inches) at end of year of life									
	1	2	3	4	5	6	7	8	9	10
Sheeds Creek	1.9	3.4	4.7	5.9	7.0	7.9	8.6	9.0	9.5	10.2
Spring Creek	2.2	4.2	6.1	—	—	—	—	—	—	—
Chipola River	3.8	8.1	11.4	13.9	15.3	—	—	—	—	—

Validity of the Scale Method for Aging Hatchery-Reared Atlantic Salmon[1]

KEITH A. HAVEY
Fishery Research and Management Division, Maine Department of Inland Fisheries and Game Augusta, Maine

ABSTRACT

Scale samples from 142 hatchery-reared lake Atlantic salmon, *Salmo salar,* of known age were studied to determine degree of correlation between known age and age as determined by scale interpretation. Salmon sampled had been marked by finclips before stocking and had been at large for 1 to 5 years. They were survivors of three successive stockings of 16-month-old (from hatching), fall-stocked fish. All scales were taken from angled salmon checked during a continuing creel census at Long Pond, Hancock County, Maine.

Approximately 80 percent of the 142 fish could be correctly aged by employing usual criteria for annulus location. Winter band counts were the best single criterion for aging after Age I. All ages could be determined within 1 year.

The patterns of scale growth that occurred under hatchery conditions were usually more irregular than patterns formed under lake conditions. These irregularities led to most errors in age determination. Scale absorbtion associated with reproduction was not a source of error in aging. However, only 10 scales showed spawning marks, and no scales were examined that indicated more than one spawning. Slow growing fish were as readily aged as rapidly growing individuals.

INTRODUCTION

Validity of the scale method for determining ges of fish is well established. Among others, able (1956), Cooper (1951), and Rich and Holmes (1929), who employed recoveries of atchery or wild stock of known age, have onvincingly demonstrated the high reliability f the method for aging salmonids.

The lake Atlantic salmon, *Salmo salar,* is one f Maine's important cold-water game species. rowth rates and population age-group structures determined from scale samples often nfluence choice of salmon management techiques. High accuracy in age determination is mperative.

The purpose of this paper is to point out me sources of error associated with aging ke Atlantic salmon of hatchery origin and o define some techniques helpful in aging is species.

MATERIALS AND METHODS

Scales used for the study were obtained om 142 hatchery-reared, fin-clipped salmon hecked during creel censuses conducted at ong Pond, Hancock County, Maine from 954 to 1957[1]. All salmon were Age I + hen stocked.

Scales were taken from the side of the fish below the origin of the dorsal fin but above the lateral line. Two to five good scales were selected from the sample taken from each fish, cleaned with a soft brush and dilute solution of liquid detergent, and impressed on plastic slides softened by heat or acetone. Scales so cleaned made excellent mounts for study purposes. Readings were made with a binocular microscope at 30 to 90 magnifications. All scales were read at least twice with a substantial time interval between readings. Regenerate scales were discarded.

Criteria established for assignment of annuli included crossing over, change in growth pattern, and crowded or discontinuous circuli. Checks, that is, unusual features in scale growth pattern, that demonstrated all three of these characteristics were designated year marks or annuli. It should be pointed out that some bias was inevitable because of the writer's acquired familiarity with the distinct growth patterns of the three groups of salmon studied.

DISTRIBUTION OF ERRORS IN AGING

Approximately 80 percent of the salmon could be aged correctly by employing the criteria listed above. Twenty-six of the 28 errors were associated with irregular scale growth during the first 16 months of the life of the fish in a hatchery environment. Extra annuli, all located between the first true annulus and the focus, were found on scales of 21 of the 82

[1]This study was partly financed and administered rough Federal Aid, Dingell-Johnson Act. (Project 2-R, Maine).

FIGURE 1.—Scale of 5-year-old lake Atlantic salmon of Lot I. Annuli I, II, III, IV, V; Spawning check S; False annulus X. Note distinct winter bands of circuli preceding annuli II-V.

FIGURE 2.—Scale of 6-year-old lake Atlantic salmon of Lot 1. Annuli I, II, III, IV, V, VI. Note distinct winter bands of circuli preceeding annuli III-VI.

salmon of Lot 1 (Table 1). The first annulus was indiscernible on 5 of the 57 salmon of Lot 3. The remaining two errors consisted of one under- and one over-determination of age not associated with scale growth in hatchery environment.

A false annulus typical of those found between the focus and first true annulus on scales of salmon of Lot 1 is designated X in Figure 1. Figure 2 is a scale of a salmon of Lot 1 that shows no false annulus in the corresponding location on the scale.

The 21 errors associated with hatchery scale growth of fish of Lot 1 were distributed as follows by age-groups:

Age group	Number of fish	Number of errors
II	1	0
III	8	0
IV	15	4
V	30	9
VI	28	8

Scales from 10 of the fish demonstrated spawning checks. Blair (1937) points out that scale absorbtion associated with reproduction leads to serious errors in determining ages of lake Atlantic salmon. No scales examined in the present study demonstrated more than one spawning check and these single checks caused no errors in aging. A spawning check typical of those observed in the present study is designated S in Figure 1.

CAUSES FOR FALSE OR MISSING ANNULI ON SCALES

Rich and Holmes (*op. cit.*) noted that false annuli commonly occurred between the first true annulus and the focus of king salmon, *Oncorhynchus tshawytscha*. Termed incidental checks by Rich and Holmes, these false annuli often made assignment of the first year mark difficult. Possibly extra annuli noted at this location in the present study represent a first-year scale growth pattern characterized by rapid growth in spring and early summer, a slowdown or cessation of growth during midsummer months, and rapid growth again in late summer and the fall. Hatchery personnel have confirmed that such a growth pattern is not unusual for hatchery-reared salmon. It should be noted here that virtually all scales of fish of Lot 1 studied demonstrated a break in growth pattern between the focus and first true annulus. However, all such checks were not sufficiently well-defined to be termed annuli under the criteria established for annulus assignment.

The reason for the absence of the first annulus on the scales from five salmon of Lot 3 is not known. Possibly some salmon failed to reach lengths at which scales form (approximately 30 millimeters) in the first year or developed so few circuli that the first annulus was not discernible.

Lots 1 and 3 originated in different hatcheries. Only fish of Lot 1 demonstrated extra first-year checks (false annuli) and only Lot 3 had fish that lacked true first-year annuli. The possibility of characteristic growth patterns for different salmon rearing stations should be investigated.

AGING TECHNIQUES

Winter bands were the scale features most helpful in locating year marks. These more or less distinct bands of crowded and broken circuli preceeding rapid-growth bands of circuli (Figures 1 and 2) accurately indicated the approximate position of the annulus in both slowly and rapidly growing salmon. Winter bands were generally most obvious on scales of age groups III to VI, and were most easily seen along the anterior scale radius. Crossing over was most obvious in the lateral fields.

The first annulus was usually located between the fifth and twentieth circulus. Crossing over and discontinuous circuli were both useful in locating the first year mark.

TABLE 1.—*Source and time at large of angled salmon of known age at Long Pond, 1954-1957*

Lot number	Number stocked	Month stocked	Mark	Size (inches)	Number of samples by time at large (years)				
					1	2	3	4	5
1	3,000	Sept.	Left and right pelvic	7.5 ± 0.10	1	8	15	30	28
2	3,005	Oct.	Adipose and left pelvic	5.7 ± 0.05	..	2	1	.....	.....
3	3,266	Oct.	Adipose and right pelvic	4.9	1	21	35		
				Totals	2	31	51	30	28

APPRAISAL OF THE SCALE METHOD FOR SALMON

The present study indicates that seasonal growth rate changes are reflected on scales of lake Atlantic salmon in their lake habitat thus making them reliable indicators of salmon age over a wide range of ages and growth rates. Annuli formed on scales while the salmon are in the hatchery are less easily located, and incidental or missing checks on the scales of such fish lead to some error in aging. Some incidental checks were found to have all the usual characteristics of an annulus.

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Ecology and Control of the Columbia Squawfish in Northern Idaho Lakes

PAUL W. JEPPSON AND WILLIAM S. PLATTS
Idaho Fish and Game Department, Sagle, Idaho

ABSTRACT

Columbia squawfish, *Ptychocheilus oregonensis,* and trout were found to occupy similar niches, resulting in competition for food and space, and predation on each other. Mature squawfish are piscivorous with food habits similar to Dolly Varden, *Salvelinus malma,* rainbow trout, *Salmo gairdneri,* and brown bullhead, *Ictalurus nebulosus.* Age and growth data are presented and in northern Idaho lakes a 13-year-old female squawfish attains a maximum weight of approximately 9 pounds. Males grow slower, averaging less than one half the size of the females. Spawning by lake populations occurs in lakes and streams. Lake spawning is in schools during late May and early June over wave-washed rubble on clear, calm days. The number of eggs in mature females varies from 12,000 to 100,000, averaging 40,000. Eggs hatch in 7 to 8 days. In six years of squawfish control in 3,800-acre Hayden Lake by dynamiting and gill netting spawning schools, mature squawfish were reduced to about one-tenth of their original abundance and an increase in trout noted.

INTRODUCTION

The Columbia squawfish, *Ptychocheilus oregonensis,* is an undesirable fish in many northern Idaho waters because it competes for food and preys upon more desirable game fishes, especially rainbow trout, *Salmo gairdneri,* cutthroat trout, *Salmo clarki,* Dolly Varden trout, *Salvelinus malma,* and kokanee, *Oncorhynchus nerka kennerlyi.* Since complete eradication of squawfish is not practical in large lakes, control methods are desirable which will reduce the numbers and check the increase of this large cyprinid. In the lowland lakes of northern Idaho the squawfish has been increasing in abundance and extending its range because: it is adapted to most aquatic environments, including streams and oligotrophic lakes; it is favored by selective fishing for other fish; it thrives in new impoundments; and it is sometimes inadvertently transported and stocked by man.

To gather information on this fish to use in control of it, studies of its life history and relationships to other fishes were made in three northern Idaho lakes: Cocolalla, 800 acres; Pend Oreille, 80,000 acres; and Hayden 3,800 acres. Various control measures were instituted at Hayden Lake. These lakes are predominantly oligotrophic, relatively infertile, and are fished mostly for trout or kokanee (Figure 1).

Fish were collected from the lakes in 1953, 1957, and 1958 with gill nets, by use of dynamite and rotenone, and from the sport fishery. The experimental gill nets of nylon thread were 6 feet deep, of 25-foot sections and of 1½-, 2-, 2½-, 3-, and 4-inch mesh (stretch measure). Gangs of linen or cotton nets of 3-, 3½-, 4-, and 5-inch mesh were also used.

FISH ASSOCIATIONS AND SPORT FISHERY

From Hayden Lake the following species of fish were taken by netting: yellow perch,

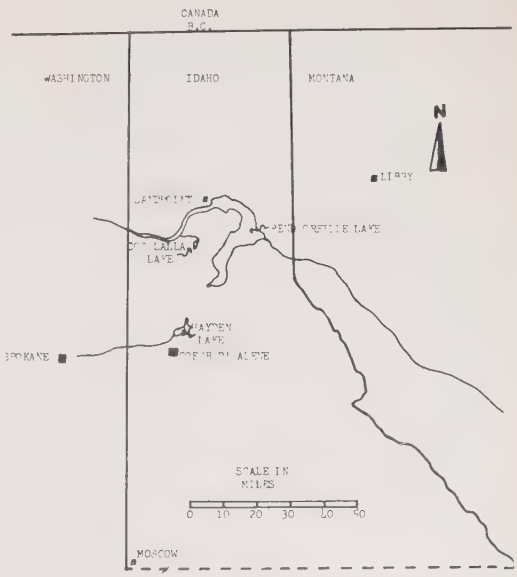

FIGURE 1.—Upper Idaho showing location of lakes from which squawfish and associated fishes were collected.

Perca flavescens, squawfish, longnose sucker, *Catostomus catostomus,* mountain whitefish, *Coregonus williamsoni,* rainbow trout, cutthroat trout, black crappie, *Pomoxis nigromaculatus,* brown bullhead, *Ictalurus nebulosus,* largemouth bass, *Micropterus salmoides,* and tench, *Tinca tinca.* As judged from gill-net catches (Table 1) yellow perch, longnose suckers, and squawfish were the commonest species present. This lake supplies sport fishing primarily for rainbow and cutthroat trout. Fishing for perch and warm-water species is less popular. A small winter fishery for whitefish occurs intermittently.

In Cocolalla Lake the nets took Columbia River chub, *Mylocheilus caurinus,* pumpkinseed sunfish, *Lepomis gibbosus,* and Columbia largescaled sucker, *Catostomus macrocheilus,* in addition to the ten species named above. Here, yellow perch, suckers, sunfish, and squawfish were the commonest species in the net catches. Fishing activity was quite similar to that at Hayden Lake, anglers primarily seeking trout. Cocolalla Lake was treated with rotenone and restocked with cutthroat trout in 1957.

Net catches from Pend Oreille Lake included lake whitefish, *Coregonus clupeaformis,* kokanee, and Dolly Varden trout in addition to the species found in Cocolalla Lake. Perch, kokanee, Columbia River chub, squawfish, suckers, and lake whitefish are believed to be the commonest species. Kokanee are pelagic and were therefore infrequently taken in gill nets, which were usually set inshore. This lake is famous for its catches of record-size rainbow trout and abundant kokanee, but anglers also commonly take cutthroat and Dolly Varden trout, whitefish, perch, crappie, and bass.

Records of gill-net sets in northern Idaho lakes indicate squawfish are demersal and fairly well distributed to depths as great as 60 feet, occupying roughly the same habitat as trout. This concurs with the findings of Forester and Ricker (1941), who collected squawfish from Cultus Lake. They had most success when gill nets were set near shore during the spawning period and, following spawning, poor catches of squawfish were made until mid-September, after which they were most easily taken offshore.

FOOD HABITS AND INTERSPECIFIC COMPETITION

Stomachs were removed from fish taken by gill netting, by dynamiting, and from the catches of sport fishermen. Food items in the stomachs were identified and measured volumetrically by water displacement. In all, the contents of 205 stomachs from 9 species of fish were examined from Pend Oreille Lake,

TABLE 1.—*Selectivity*[1] *of gill nets of several mesh sizes for squawfish and associated species in Hayden, Cocolalla, and Pend Oreille Lakes, Idaho, 1953 to 1958*

[Experimental nets have nylon webbing; others are linen or cotton; mesh measurements are stretch measure; (—) indicates species not taken]

Gear	Experimental gill net[2]			3-inch gill net			3½-inch gill net			4-inch gill net			5-inch gill net		
Lake	Hayden	Cocolalla	Pend Oreille	Hayden	Cocolalla	Pend Oreille	Hayden	Cocolalla	Pend Oreille	Hayden	Cocolalla	Pend Oreille	Hayden	Cocolalla	Pend Oreille
Net—days[3]	7	2½	116	12	81	27	12	81	24	615	273	36	229	51	20
Mean number days between lifts	3	1	1.8	2.0	1.1	1.3	2.0	1.1	1.3	2.5	1.4	1.3	2.5	1.1	1.3
Yellow perch	4.00	14.80	3.93	0.75	0.16	0.04	0.58	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00
Squawfish	0.86	9.20	1.04	8.58	0.88	0.11	4.50	0.12	0.00	1.65	0.44	0.00	0.27	0.00	0.00
Suckers	2.57	2.00	0.76	0.42	1.72	0.11	1.17	0.37	0.04	0.27	0.12	0.00	0.00	0.00	0.00
Mountain whitefish	4.71	0.00	0.32	0.00	0.56	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Rainbow trout	1.86	1.20	0.09	0.00	0.22	0.00	0.00	0.14	0.00	0.04	0.14	0.00	0.00	0.00	0.00
Cutthroat trout	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.00
Black crappie	0.00	0.00	0.10	0.00	0.00	0.22	0.00	0.00	0.00	0.02	0.02	0.00	0.00	0.00	0.00
Brown bullhead	0.00	4.00	0.01	0.00	0.26	0.00	0.00	0.02	0.00	0.00	0.03	0.00	0.00	0.00	0.00
Largemouth bass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
Tench	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.19	0.00	0.15
Columbia River chub	—	2.00	1.37	—	0.00	0.00	—	0.00	0.00	—	0.00	0.00	—	0.00	0.00
Pumpkinseed sunfish	—	1.60	0.07	—	0.40	0.00	—	0.00	0.00	—	0.00	0.00	—	0.00	0.00
Redside shiner	—	0.00	0.00	—	0.00	0.00	—	0.00	0.00	—	0.00	0.00	—	0.00	0.00
Lake whitefish	—	—	0.43	—	—	1.19	—	—	0.62	—	—	0.03	—	—	0.00
Kokanee	—	—	0.08	—	—	0.00	—	—	0.00	—	—	0.00	—	—	0.00
Dolly Varden trout	—	—	0.09	—	—	0.00	—	—	0.00	—	—	0.00	—	—	0.00

[1] The catch index used is the average number of fish taken in 100 lineal feet of gill net per 24-hour period.
[2] Experimental net has 6 x 25-foot sections of 1½-, 2½-, 3-, and 4-inch mesh (stretch measure).
[3] Net-day is 100 lineal feet of gill net for a 24-hour period.

148 stomachs from 6 species from Hayden Lake, and 100 stomachs from 5 species from Cocolalla Lake. These data are presented in Table 2.

It will be observed from Table 2 that the food of squawfish in all three lakes was more than 58 percent fish, being of mixed species in Hayden Lake, yellow perch in Cocolalla Lake, and kokanee in Pend Oreille Lake. Rainbow trout, which occurred in all three lakes, also fed on fish (29 to 79 percent of the food was identified as such) but utilized insects (12 to 56 percent). Perch in the three lakes fed mostly on crayfish and insects. Cutthroat trout fed almost entirely on insects and mountain whitefish on insects and scuds. Lake whitefish, taken only from Pend Oreille Lake, had fed on insects, mollusks, and plant material; Dolly Varden trout mostly on kokanee; brown bullheads on fish, plant material, crayfish, earthworms, and scuds; black crappie on fish, insects, crayfish, plant material, and *Daphnia;* and Columbia River chub on mollusks, insects, and plant material.

Feeding habits of squawfish and the three species of trout were also examined in relation to fish size. Table 3 shows feeding habits for these four species by 4-inch length intervals. It will be observed that all are predominantly insect feeders when shorter than 12 inches and, with the exception of cutthroat, are primarily fish-eating when longer than 16 inches. At the 8- to 12-inch interval, squawfish utilized more crustaceans and mollusks than did trout and, with growth, shifted more rapidly to a fish diet than did either rainbow or cutthroat trout but less abruptly than Dolly Varden.

It is apparent from the food habits of these fishes that the squawfish is an important competitor for food with rainbow and Dolly Varden trout and to a lesser extent, competes with the cutthroat, crappie, bullhead, and perch.

AGE AND GROWTH OF SQUAWFISH

In 1957 scales were taken for aging from 40 squawfish in Pend Oreille and 83 in Cocolalla Lakes. Using a projector, scale measurements were made and growth calculated to the time

TABLE 3.—*Food habits of squawfish, rainbow trout, Dolly Varden trout, and cutthroat trout from three northern Idaho lakes by 4-inch length intervals, expressed as percentages of total volume.*[1]

Item	Range in total length (inches) 0.1 - 4.0	4.1 - 8.0	8.1 - 12.0	12.1 - 16.0	16.1 - 20.0	over 20
Squawfish						
Stomachs containing food	13	7	9	18	35	1
Total volume (milliliters)	tr.	0.6	3.3	36.7	353.2	32.0
Fish	12	50	18	94	86	100
Insects	88	50	43	3	tr.	0
Crayfish	0	0	30	0	6	0
Scuds	0	0	3	tr.	tr.	0
Mollusks	0	0	3	0	tr.	0
Plant material	0	0	3	2	7	0
Rainbow trout						
Stomachs containing food	0	3	32	32	18	6
Total volume (milliliters)	.....	1.4	107.9	296.6	195.3	236.0
Fish	.....	0	0	22	90	100
Insects	.....	100	96	75	9	0
Plant material	.....	0	4	2	1	0
Dolly Varden trout						
Stomachs containing food	0	1	1	5	4	14
Total volume (milliliters)	.....	0.1	0.4	98.1	25.4	1048.0
Fish	.....	0	0	75	100	100
Insects	.....	100	100	tr.	0	0
Earthworms	.....	0	tr.	16	0	0
Scuds	.....	0	0	tr.	0	0
Fish eggs	.....	0	0	8	0	0
Cutthroat trout						
Stomachs containing food	0	3	16	17	2	0
Total volume (millilters)	.....	2.5	50.2	103.9	7.3	
Fish	.....	0	6	tr.	15	
Insects	.....	100	93	93	85	
Earthworms	.....	0	0	6	0	
Plant material	.....	0	1	tr.	0	

[1] Food of squawfish less than 4 inches in length is expressed as percentages of occurrence rather than volume.

TABLE 2.—*Food of squawfish and associated fishes in three northern Idaho lakes expressed as percentages of total volume of combined stomach contents for each series.*

[Figures in parentheses are numbers of stomachs represented; dash (—) indicates species not sampled.]

Food item	Lake	Species									
		Squawfish	Rainbow trout	Dolly Varden trout	Cutthroat trout	Mountain whitefish	Lake whitefish	Yellow perch	Brown bullhead	Columbia River chub	Black crappie
Fish	Cocolalla	*58 (40)	*29 (23)	—	—	0 (10)	—	0 (11)	*71 (16)	—	—
	Pend Oreille	**96 (21)	**79 (22)	**98 (25)	5 (20)	0 (10)	0 (39)	4 (55)	—	0 (11)	100 (2)
	Hayden	†81 (23)	†34 (46)	—	*1 (18)	—	—	†7 (35)	43 (5)	—	† 10 (21)
Insects	Cocolalla	1	12	—	—	100	—	0	7	—	—
	Pend Oreille	3	20	tr.	91	77	12	87	—	32	tr.
	Hayden	1	56	—	99	—	—	3	1	—	68
Crayfish	Cocolalla	0	0	—	—	0	—	98	0	—	—
	Pend Oreille	1	0	0	0	0	0	0	—	0	0
	Hayden	18	tr.	—	0	—	—	87	18	—	6
Scuds	Cocolalla	tr.	tr.	—	—	0	—	0	7	—	—
	Pend Oreille	tr.	tr.	tr.	0	19	tr.	8	—	tr.	0
	Hayden	0	0	—	0	—	—	0	0	—	0
Earthworms	Cocolalla	tr.	tr.	—	—	0	—	0	12	—	—
	Pend Oreille	0	0	1	3	0	0	0	—	0	0
	Hayden	0	0	—	0	—	—	0	0	—	0
Mollusks	Cocolalla	tr.	0	—	—	0	—	2	0	—	—
	Pend Oreille	tr.	0	0	tr.	0	28	tr.	—	52	0
	Hayden	0	0	—	0	—	—	2	tr.	—	0
Fish eggs	Cocolalla	0	0	—	—	0	—	0	0	—	—
	Pend Oreille	0	0	1	0	0	0	tr.	—	0	0
	Hayden	0	0	—	0	—	—	1	0	—	0
Daphnia	Cocolalla	0	0	—	—	0	—	0	0	—	—
	Pend Oreille	0	0	0	0	0	0	tr.	—	0	tr.
	Hayden	0	0	—	0	—	—	0	0	—	4
Indeterminate animal food	Cocolalla	31	56	—	—	0	—	0	0	—	—
	Pend Oreille	0	0	0	0	0	3	0	—	7	0
	Hayden	0	8	—	0	—	—	0	0	0	8
Plant material	Cocolalla	10	3	—	—	0	—	0	3	—	—
	Pend Oreille	tr.	1	0	1	4	57	1	—	9	0
	Hayden	tr.	2	—	0	—	—	tr.	††38	0	4

* Mostly yellow perch.
** Mostly kokanee.
† Mixed species including trout, suckers, and perch.
†† Algae.

of annulus formation, assuming a straight-line relationship between scale and body growth. These data, which are presented in Figure 2, show most rapid growth during the second and third years of life (annulus I to III): 2 to 3 inches a year. The oldest squawfish taken showed 13 annuli and a weight of 9 pounds. Spawning males in Hayden Lake had average total lengths of 15.4 and 14.0 inches in 1957 and 1958, respectively, and weighed from 0.6 to 3.0 pounds. Spawning females were larger, averaging 20.2 and 20.3 inches in these same years and weighing from 1.4 to 7.6 pounds.

Total length and fork length of squawfish were compared, using 35 fish. Conversion factors are: within a range in length of 50 to 120 millimeters, total length equals 1.114 times fork length which equals 1.150 times standard length; and within a range of 120 to 530 millimeters, total length equals 1.087 times fork length which equals 1.094 times standard length.

SPAWNING AND FECUNDITY OF SQUAWFISH

Squawfish spawn in both lakes and streams. Migration from lakes into streams for the purpose of spawning apparently occurs where lakeshores are unsuitable for spawning.

Squawfish congregate when the water temperature on the spawning grounds nears 60° F. Spawning occurs on clear, calm days. The eggs are broadcast in shallow water, usually less than one foot in depth. Spawning is characterized by vigorous splashing and vibrations. Both sexes strip easily when ripe and sex of males can be determined externally by the presence of spawning tubercles, darker coloration, and slender genital papilla. Eggs adhere loosely to the surface of rocks or form mats in the interstices. There is no parental care given eggs or young. Normally eggs hatch in 7 to 8 days. Spawning generally occurs during a one-month period of late spring or early summer unless prolonged by periods of rough weather. After hatching, young squawfish school in shallow water for several weeks, at which time they are vulnerable to treatment with rotenone.

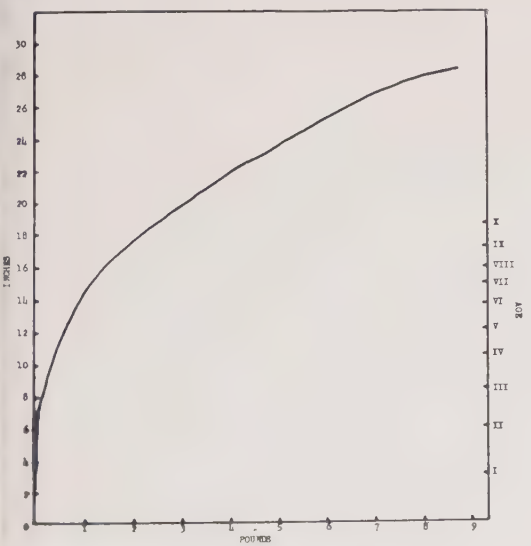

FIGURE 2. Age, weights, and mean total lengths of squawfish in Idaho lakes, Length-age data from Cocolalla and Pend Oreille Lakes. Length-weight data from Cocolalla, Pend Oreille, and Hayden Lakes.

At Hayden Lake the principal spawning grounds are located along one mile of the 28-mile shoreline, where eroding bluffs deposit angular rubble along the edge of the water. Interstices in the rubble, together with wave action, make the site ideal for survival of eggs. Squawfish at Cocolalla Lake spawned successfully on wave-washed cobbles embedded in clay and sand.

The fecundity of northern Idaho squawfish was estimated by measuring the total volume of eggs in each gravid female. The total number of eggs was then determined by pro-rating from actual counts of eggs in known unit volumes. A ripe 16-inch, 1½-pound female carries about 12,000 eggs. In larger female squawfish, eggs may total 100,000 or more, averaging ⅛ of the body weight. Egg production per pound of fish was found to be lowest at first spawning, 8,000 to 10,000 per pound of fish, but was from 12,000 to 16,000 per pound of fish thereafter.

Dynamiting, which was presumably not selective to sex or size, showed a sex ratio of 55 percent females to 45 percent males. Gill nets of 3- to 5-inch mesh were selective to females because of their larger size. Because of selectivity of gill nets, 81 and 85 percent of the squawfish collected from Hayden and Cocolalla Lakes, respectively, were females.

SELECTIVITY OF GILL NETS IN SAMPLING OF SQUAWFISH

Since gill nets are a practical means of reducing squawfish populations, the selectivity of such gear for squawfish of different size is of interest. The nets fished, including experimental nets, allowed evaluation of catch efficiency of seven mesh sizes; 1½-, 2-, 2½-, 3-,

3½-, 4-, and 5-inch mesh. It should be repeated that the three smaller mesh sizes were of nylon thread and the larger were of linen and cotton, since this may have affected the efficiency of the nets, nylon being subject to slight stretching when wet (Lawler, 1950). Mean size of squawfish (in inches) taken from the different size meshes with associated standard deviations are: 1½-inch mesh—8.3±0.7 inches; 2-inch mesh—10.1±0.9; 2½-inch—13.3±1.7; 3-inch—14.3±2.0; 3½-inch—15.8 ±1.3; 4-inch—18.1±1.7; and 5-inch mesh—20.4±0.8 inches. These means represent measurements of 356 squawfish taken from Hayden, Pend Oreille, and Cocolalla Lakes in 1953, 1957, and 1958.

Squawfish taken by dynamiting on spawning beds of Hayden Lake in 1957 and 1958 (35 males and 85 females) showed a mean length of 14.4 inches for males and 20.3 inches for females with associated mean weights of 1.2 and 3.2 pounds. It is apparent that the best mesh sizes for taking spawners are 3, 3½, and 4 inches.

CONTROL MEASURES

Reduction of squawfish numbers in Hayden Lake began in 1953 with gill netting and dynamiting of spawning schools (Jeppson, 1957). Control work by dynamiting and *partial* spot treatment of the lake with rotenone was done in following years. In order to appraise the effectiveness of the six-year program, gill nets were again used in 1957 and 1958 along the one mile of shoreline where squawfish concentrate for spawning, duplicating the work done in 1953 when the project started. Four- and 5-inch mesh gill nets were set on the bottom in 6 to 30 feet of water in gangs or at angles to the shoreline as bottom contour and obstructions permitted.

Effect on Squawfish

An estimated 24,000 pounds of squawfish were killed during the six seasons of work at Hayden Lake. This represents a kill of about 6⅔ pounds of squawfish per surface acre; considerably more than the estimated standing population of squawfish in Cocolalla Lake—which amounted to less than one pound per surface acre, as determined by sampling dead fish following total eradication with rotenone in 1957.

At Hayden Lake the catch indices (catch per 100 feet of net per 24-hour period) of squawfish declined 90 percent (3.46 in 1953; 0.77 in 1957; and 0.34 in 1958) in 4-inch mesh and 52 percent (0.44 to 0.21) in 5-inch mesh during the period of study. Four-inch-mesh nets were operated for 215, 137, and 235 net days and five-inch mesh nets for 57, 51, and 130 net days in 1953, 1957, and 1958, respectively.

More frequent tending of gill nets has been demonstrated to have the effect of increasing catches, especially when levels of fish abundance are high (Kennedy, 1951). Nets were lifted at average intervals of 2.8, 2.0, and 2.6 days in 1953, 1957, and 1958, respectively. Since levels of squawfish abundance and total catches were higher during 1953 and tending nets was less frequent, bias from this source tends to make the estimate of squawfish reduction conservative.

Effect on other fish

A slight increase in the catch indices for tench was likely due to the suspension of an effective trap-netting program in shallow bays after 1953. The catch index for trout during the six years was doubled. Sport fishing was much improved as shown by creel checks; the ratio of marked hatchery rainbows indicated that improved trout fishing was due in part to stocking, but, apparently, survival of trout as a result of squawfish control was a contributing factor.

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The Invasion of Manitoba and Saskatchewan by Carp[1]

F. M. Atton

Saskatchewan Fisheries Laboratory, Department of Natural Resources
University of Saskatchewan, Saskatoon, Saskatchewan

ABSTRACT

The history of carp introductions and establishment in the Nelson River drainage is reviewed. Present distribution (1957) and possible points of invasion are shown. The rate of movement is examined and the importance of infertile and cold water as an ecological barrier is suggested.

The recent appearance of the carp, *Cyprinus carpio,* in Saskatchewan has encouraged an investigation of its origin and distribution in the water systems which it occupies. Dymond (1955) has reviewed the introduction of carp into Ontario between 1880 and 1893 and points out the initial enthusiasm of Canadian fisheries personnel for this species.

In Manitoba similar confidence in an easy food supply for new settlers appears in the report of Mr. Alex McQueen, Inspector of Fisheries, Manitoba and N. W. T., in the Sessional Papers of the Dominion of Canada, 1886. This officer reports that on 22 November, 1885, he received 100 carp, six months of age, from the hatchery at St. Paul, Minnesota. These fish were placed in ponds at Springfield, Portage la Prairie and Minnedosa. In the following year a further supply of carp was obtained from the same hatchery by a private individual, but no mention is made of the success of either of these efforts to introduce the species.

Failure to establish this "excellent food fish" (Sessional Papers 1886) is not to be blamed upon those charged with fishery administration, for in late autumn, 1889, a shipment of carp was obtained from the U. S. Fishery Commissioner, Washington. The inspector planted these fish in a mill pond near Rapid City, and in Lake Minnewawa near Glenboro, Southern Manitoba. It thus seems certain that carp were introduced into water tributary to the Assiniboine River system at the Rapid City site as early as 1889. In the same year however, there was a strong recommendation from F. C. Gilmarist, Fishery Overseer at Fort Qu-Appelle, District of Assiniboia, to the effect that bass instead of carp should be introduced into the lakes of the Qu'Appelle valley. There is no mention of carp in reports after 1890, though in the following year a rather extensive report on the useful varieties of fish was prepared.

Hinks (1943) states that carp were unknown in Manitoba until 1938. If the introduction in the late nineteenth century in the settled parts of the province had been successful, it is difficult to understand a period of 49 years during which there was no report of the species. It seems reasonable to conclude that these early introductions were not successful in Manitoba, especially since Hinks' record, which is the first acceptable one, is well removed from the sites mentioned.

In Saskatchewan the earliest acceptable record for the occurence of carp is for the Frenchman River in the southwestern corner of the province. In this tributary of the Milk River (Missouri system) there have been carp populations since 1921. The species has not spread in this area because there are very few permanent waters in the semi-arid country to the north and east.

The real spread of carp began in 1938 in the Red River with the first record at Lockport, Manitoba, near the United States boundary. The progress of this invasion of the Nelson drainage and the present boundary of distribution is shown in Figure 1. Carp now occur in waters to the south and east of the broken line. A specimen was taken at the Winnipeg River in 1943 (Hinks 1943) and near the north end of Lake Winnipeg (Mukatawa River) in 1954 (Keleher 1956). The most northern record is Cross Lake on the Nelson River, 1956 (Keleher and Kooyman 1957). Considerable field work in the Cumberland Lake area and on the Saskatchewan River has not produced any evidence of their presence. The species was first identified in Saskatche-

[1]Contribution from the Fisheries Branch, Saskatchewan Department of Natural Resources, Prince Albert, Saskatchewan.

wan at Kamsack on the Assiniboine River in 1953. It occurred in only small numbers in the two lower Qu-Appelle lakes in 1953 and was unknown upstream. By 1955 there was a large population in the lower lakes and specimens were (reported) captured in Pasqua Lake. Further upstream movement is prevented by dams on both the Qu'Appelle and Souris Rivers, and strenuous efforts are being made to prevent their introduction above these obstacles. Such dams seem to be effective, since the species is not known in the Milk River above the Fresno Dam in Montana.

The bait bucket of the angler was a probable means of transfer of carp from the Mississippi headwaters to the Red River in North Dakota or Minnesota. The proximity of headwaters is also a possible means of access for migrating fish. During spring runoff or flood periods one of these areas may be confluent. The map indicates two such points: (i) between the Minnesota River and Big Stone Lake; (ii) between the James River and a Red River tributary. This possibility is important because there are two very narrow divides which may not prevent further invasion of the carp into Saskatchewan (Figure 1 at iii and iv). During years of abundant spring runoff there has been a continuous body of water through the extensive marsh at the source of Aitkow Creek thus joining the Qu-Appelle River to the South Saskatchewan River. This was known to the Indians, who called this creek "the river that turns" (Hind, 1860). There is also a very narrow divide between the Sturgeon and Beaver Rivers near Prince Albert National Park.

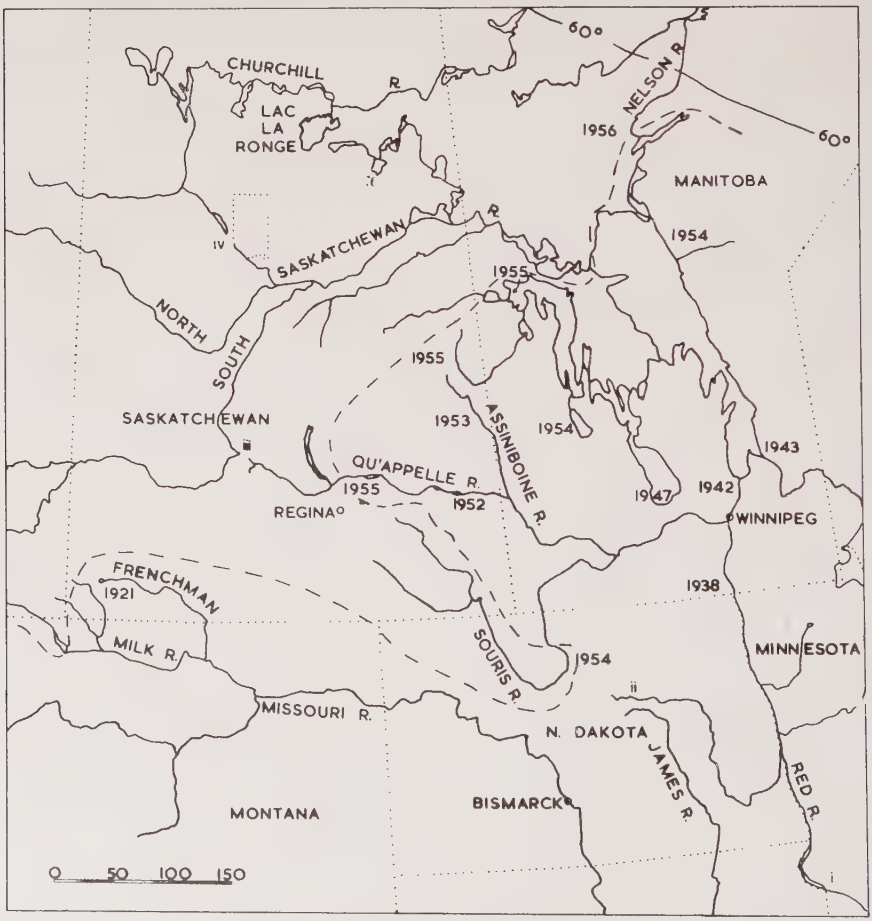

FIGURE 1. Carp distribution in Manitoba and Saskatchewan. Points of possible invasion referred to in the text are (i) Big Stone Lake, (ii) James River, (iii) Aitkow Creek, (iv) Beaver River.

The approximate rate of invasion of the carp is presented in Table 1. Distances to the various points have been measured from the 1938 occurrence near the Manitoba boundary. Between Winnipeg River and Mukatawa River in Lake Winnipeg the average was 16 miles per year. Movement appears to be faster in rivers than in lakes, with an average of about 30 miles per year. Movement in the Qu'Appelle River from Crooked Lake to Katepwa Lake averaged 33 miles per year. That these values represent average successful invasion is suggested by work on the polluted section of the Qu'Appelle River above Pasqua Lake. In this part of the stream, fish cannot overwinter. Extensive poisoning of this stream in 1958 revealed only two carp that had travelled about 55 miles during or after spring floods.

TABLE 1.—*Rate of carp invasion in Manitoba and Saskatchewan*

Water	Time years	Distance miles	Rate miles/year
Winnipeg River	5	125	35
Lake Winnipeg	16	325	20
Swan River	17	675	40
Assiniboine River	15	425	28
Qu'Appelle River	17	425	25
Souris River	16	325	20
Cross Lake	19	450	24

The northward extension of the range of carp is of much interest from both ecological and fisheries management aspects. Sigler (1955) has pointed out that cold water in summer appears to limit invasion of carp into trout habitat in Utah. Spawning activity begins at a temperature of about 58° F. and spawning takes place about 62° F. The isotherm of 70° F. mean July temperature (Thomas 1953), shown in Figure 1, is a possible boundary of northern establishment. Most of the Churchill River system is south of this isotherm, and on this basis potential carp range. Fertility of the waters of Minnesota has been noted by Moyle (1956) as related to carp distribution—the species is not in waters in that state having less than 0.05 p.p.m. total phosphorus. The soft infertile waters of the Precambrian in Manitoba and Saskatchewan, which are also cold, may be an effective barrier.

ACKNOWLEDGMENTS

I am indebted to Messrs. B. Kooyman and D. Henegar for information concerning distribution of carp in Manitoba and North Dakota respectively.

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An Approach to Population Dynamics of the Pacific Red Salmon[1, 2]

WILLIAM FRANCIS THOMPSON[3]
University of Washington, Seattle, Washington

After twenty years of study on Pacific salmon, I would like to put into words some of the fundamental concepts which seem to me to underlie research on these anadromous fish which die after spawning and on which the research I have directed since 1937, has been based. In doing so, I wish to say that this is a "thinking" paper in which are presented not facts but working hypotheses, a logical framework for research.

The life history of salmon should be an extension of the usual concepts of population dynamics. In a long-lived species, say halibut, the survival curve of a single year class must be of the form shown in Figure 1 where *maturity* is shown by the shaded area. In such case, the survival of any such generation or year class must be the accumulated result of varying conditions in a number of years; and many year classes with varying histories may be present at any one time, to interbreed and mix the genetic lines. Year by year variations in survivals are smoothed out by the intermixture of the various year classes so that the spawning is more constant in the sense that an average is more constant than one variable.

In such fish, the production of young must over a long period balance the mortalities to perpetuate the species. The number of young for each year class is the sum of those produced over a number of years. In other words the sum depends on two factors, the length of life and the number of eggs produced annually. So when fish enter an environment in which the number of young becomes less important because the mortality is less, it is conceivable that if the species is not to become over abundant, not only (1) the annual egg production may be reduced but that (2) the age reached may be less without endangering survival of the species (see Figure 2). In such case, I regard the length of life no less than the fecundity as an adaptation of the fish to its environment. The deeper such a fish penetrates into protected localities and the more perfect its mechanism of survival, the fewer the eggs it needs and the shorter its life may become. If this process proceeds, because the fish finds increasingly secure spawning places as it goes farther into the spawning environment, then not only are the eggs fewer but spawning during one year may be all that is necessary, as in Figure 3. The second and third years of spawning conceivably become surplus, to be readily sacrificed if the fish can in exchange gain security. This, in my thinking, describes the salmon.

At nearly the logical end of such a process we find red salmon spawning in uniquely favorable areas which it has reached up rapid streams, migrating from feeding grounds in the sea through lakes and into selected gravels where its eggs few in number suffice to maintain the species. But in its release from the necessity of producing eggs in the later years of life, it is free to penetrate as far as it can find energy to go. In the process, profound physiological and morphological changes take place to a greater extent than can be reversed. Such changes may advantage the species more than the loss of the inconsequential last years of spawning. It can and does go as far as its built up reserves of energy will carry it, to the utter exhaustion of its whole being and death. So our salmon spawns once and dies to reach and make full use of fresh water habitat.

Now our species consists of successive generations in which there is an approach to a clear-cut separation from those which precede and follow. Parent generation produces young and vanishes, and the young in their turn do the same. If the separation is complete, a race which could live four years would return every fourth year only, without intermixing with any of the three intermediate generations.

There is only one limit to this, perhaps and that is the necessity of the species to meet

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[1] *Oncorhynchus nerka.*

[2] Presented at the 88th Annual Meeting of the American Fisheries Society, Philadelphia, September 8, 1958. Contribution No. 53, College of Fisheries, University of Washington, Seattle, Washington.

[3] Organizer and first Director of Fisheries Research Institute, 1947 to 1958.

the eternal but slow change in the river and the climate, and to meet the occasional disastrous or merely variant year. Some power to colonize between one generation and the other must persist so that disaster in any one may be repaired. So variants in age or habit remain, and we find that nature has not left the red salmon all of one age. Some 15 percent of the runs in the Fraser are five-year-olds instead of four. In the Bering Sea some are four, five, and six.

Think, as a next step in our reasoning, what will happen to these clearly segregated generations entering a river where there is choice of spawning areas good and bad, in the sense that one area allows a high survival, the other a low. If the species were to return indifferently to good and bad areas alike, what was gained in numbers in one spawning would be lost the next; for if there were but one good area and nine bad, nine-tenths of the return from the good area would be lost. We know that our watersheds are only favorable in small part. But were any genetic strain to return to a favorable locality for successive spawnings, the act of return would favor that strain as the power of the factor of increase. Strains returning repeatedly to a favorable ground would increase in geometric progression until stopped by a limit in the capacity of some other of their linked environments. If they did not so return, a vast and continuous mortality would have to be endured, in proportion to the relative abundance of bad and good spawning grounds. The situation must be ideal for the development of return to the home stream, as favoring the far greater survival of those which do. And in fact, in our red salmons, we have proved such a return and as scientists we discuss this under the term "home stream theory" although it has long ago ceased to be a theory.

What, then, is this "home stream" looked at from the standpoint of what we may call red salmon population dynamics? Variable mortalities occur not only in the spawning area and time, but at every stage of life. The species, moving great distances, must pass through a long succession of environments, geographically and seasonally contiguous; and the survivals must be favorable in all of them, not just in one, to allow return of the next generation.

To be favorable, in a continental environment, the season of passage may be dominant in importance, not only because of food cycles but because of sharply marked annual cycles in temperature, rainfall, physical barriers and predators. So our "home stream" becomes a chain of favorable environments connected within a definite season in time and in place, in such a way as to provide maximum survival. Our home-returning red salmon is really returning to this chain. In this the spawning ground is only one, but an indispensable and ever present link; one by which we know the colony and give it a name. It happens to be

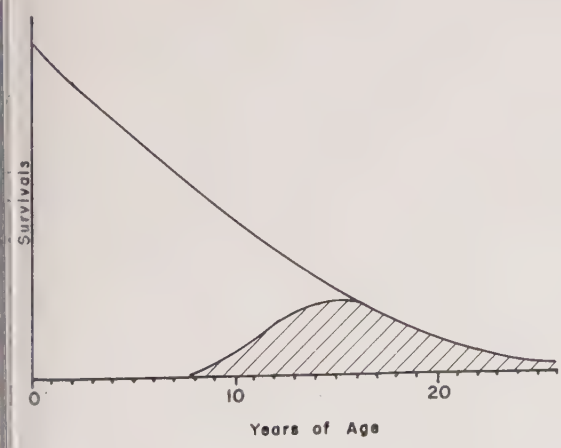

FIGURE 1. SURVIVAL CURVE OF LONG-LIVED SPECIES

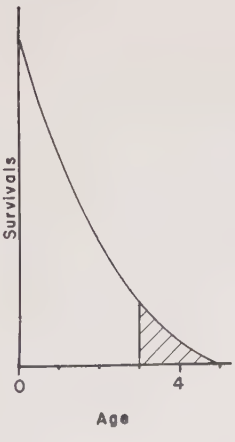

FIGURE 2. SHORT-LIVED SPECIES

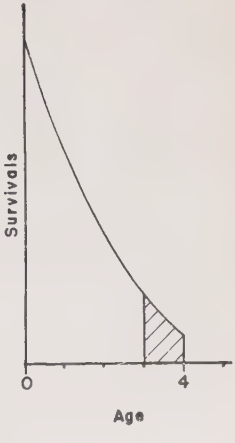

FIGURE 3. SALMON

FIGURES 1, 2 AND 3.—Survival curves of long-lived fishes, short-lived fishes and salmon

the one in which the correlation between the successive seasonal changes and the timing of developmental processes is most obvious to us, but the chain probably extends into the sea. And in our peculiar way of thinking, we attribute far greater importance to that which we see than to that which we do not. To secure successful spawning seems to us a cure-all. The hatchery then seems the answer to scarcity. The "spawning survey" seems the clue to the future return. Yet neither can be that important.

It is very apparent that there are in any river system, or in different rivers, various possible combinations or chains of this sort which can be connected in time and space in a variety of ways. It would be inconceivable that they were equally favorable. We might expect *survival* of a number of salmon home-stream colonies and *disappearance* of others.

But there must be all types of colonies intermediate between those that perish and those that live, because we see colonies in all stages of abundance, and yet all may be perpetuating themselves. Moreover, there are upper limits to the abundance, limits which are apparent in our statistics of catch plus escapement and which are very different in different colonies or races. Every colony has its characteristic level of abundance around which it varies. There must be regulatory factors, in some way dependent on density, or abundance, which enable the races to survive when few in numbers and which prevent their increase when they outgrow the capacity of any one of their linked environments.

We have occasionally seen drastic illustrations of the operation of these factors. In the Fraser River, due to obstructions dumped into the river by the railroads when passing through the mountains, formerly extremely abundant colonies, or so-called races, persisted at extremely low levels of abundance for many years until released by building of fishways past the damaging Hell's Gate obstruction, a bottle neck. When so released, abundance abruptly increased. But the question arises whether or not the racial habits once adapted to new timing have so changed as to hinder return to full abundance, just as rubber under long continued strain may lose its full resilience. A guess might be that full recovery would be relatively slow. There should be not only resilience but readaptation. However this may be, it is apparent that there is this ability to survive, a resilience under high mortalities, which is the mechanism required to permit the simultaneous existence of scarce and abundant colonies.

It follows from this reasoning that in any river system some colonies, or races, held back only by overpopulation are capable of a heavy commercial yield; others survive only by virtue of the highest rate of natural reproduction provided by resilience and are capable of very little commercial yield; and still others may require a large surplus or safety margin, to assure perpetuation. Practically, the point of maximum productivity becomes not only a matter of greatest yield but also one of what colonies are to survive, a thing only to be determined after many years. It becomes a moot question whether the species can spare anything that nature has built into it to meet the perhaps only occasional crisis. Maximum productivity is such a complex thing to determine that at present we can only find by experiment some level that looks best to us, using trial and error, and then only at the risk of ultimate disaster.

The effect of this type of life history on the runs of salmon through the estuaries in which they are fished is profound. In such an area as Bristol Bay the time within which the salmon can arrive and spawn successfully is short just as it is for the birds which nest on the Arctic shores. The salmon arrive within a very short interval each year, a timing closely adapted to the stream and lake conditions. In others such as the reds in the Fraser and the kings in the Columbia, the times of arrival of the races are spread over a long season.

Nature seems to tell us something by her own "trial and error". The runs into a river mouth, composed of many genetic strains, rise during the season to a maximum and then decline. The time that the maximum occurs must be that which has been best adapted to reproduction of the particular colonies which in the past have run at that time, because the numbers surviving then were greater. It is a temptation to say that those are the best fitted to survive which have the highest rate of reproduction and are most numerous.

After the first discussion of this in our research conferences of 1950 and 1951, the first reaction was to say that fish taken during the early and late parts of the season were less valuable for reproduction and should be used instead of being protected as is now the rule. But this was to forget that when conditions of life change as is always happening the off peak races may be the major hope for survival of the species. In warm winters only

late arrivals may emerge from the gravel at the proper feeding time. To sacrifice them may be a mistake; to use them for maximum productivity an error.

In the life history we have outlined, the history of a variation in abundance, or rather in mortalities, remains a major problem fundamental to management. Whether the variation is due to the catch, conditions of spawning, or otherwise, the question is whether or not nature compensates for these in the steps of life that follow.

There are several ways this may happen. A variation in mortality at an early age is followed by many others, plus or minus, which in sum total may overshadow the first. The earliest one may affect the average of many later, but slightly. If it is one of fifty of the same average magnitude, it may have in the end but a fiftieth of the effect it seems to have at the time. Or the mortality rates may be subject to density connected factors and the question arises whether resultant over and under abundances are not brought together and hence back to the normal by compensatory changes in later survival rates.

Or again, the major mortalities may occur in one or two early stages of life, so that the general level of abundance measured shortly after seaward migration may prevail until after the commercial catch. Races in different rivers and even within a river, vary in their own patterns, leading us to believe that their abundance is decided, not while they are feeding together in the sea but while they are segregated in different environments in fresh water. We seem to have this in Bristol Bay, where a measure of the abundance of seaward migrants seems to be providing a usable forecast of returns from the sea.

In our actual records, these explanations that mortality is either subject to resilience because of density connected factors or is overwhelmed by the sum of later variations might be adequate to explain the observable lack of a significant correlation between the escapement to spawn in one generation and the return in the next.

But to solve the problem, as to what happens to variations in survivals at various stages of life as they progress, there is needed most urgently accurate and economical means and methods of sampling and measuring abundance at various stages. The development of these methods of sampling is a story all by itself.

There is in all this as yet, one conclusion of major importance, that there is no distinct correlation between the variations in abundance of the spawning adults and of those that return. The curve of abundance swings now below the normal and now above the normal. So far as we can see, any one period below normal does not mean a continuance of abundance below normal. A theory of rational fishing depends on finding out by accurate determination where and when and why those changes in abundance occur and how long they last.

This is true not only of irregular changes but also of those which occur in regular cycles. One is tempted to say that these regular cycles are dependent on natural cycles in abundance of food and predators in freshwater stages. If food reaches a maximum and predators a minimum five years after a big run then the favored generation, having genetic continuity as described earlier, returns at the proper time to have its rate of increase compounded until a halt is called by limitations in some link in the chain of environments. In waters where salmon are of dominant importance, the scarcities of food and abundance of predators built up during good cycle years must depress off cycle generations in those years that follow. Fish reaching an age of five years establish a genetic continuity between successful generations just as in return to the home stream. Then big run is followed by big run at five year intervals, and a five year cycle is established. So, by tying together in genetic continuity years and places of high production in harmony with those of its environment our red salmon comes to have a five year life span, a return to the home stream with death at spawning and a five year cycle in abundance. The salmon life history as we know it is summed up in these characteristics.

Needless to say, understanding and management await accurate data in the form of samples and enumeration at many life stages; correlation of abundance with environmental changes awaits a time when both are pinpointed as to time and place.

Age, racial differentiations, and many other characteristics and habits are then adaptations to environment, adaptations that we must not and cannot change without disaster in any species that must survive in nature. Successful management is that government of fishing which disturbs this biological framework only in such ways as to take the best possible advantage of the inbred resilience and adaptiveness of the independent colonies or races that make up an exploited stock.

Shorter Papers and Notes

Fisheries Survey of Upper Mississippi River

The Upper Mississippi River and its fish and wildlife resources have been studied continually since 1943 when the Upper Mississippi River Conservation Committee (which commonly goes by the alphabetical designation of UMRCC) was organized. This committee is composed of members of the conservation agencies of the five states of Minnesota, Wisconsin, Iowa, Illinois and Missouri and works in cooperation with the U. S. Army Corps of Engineers, U. S. Public Health Service and the U. S. Fish and Wildlife Service. The present coordinator of the work — the writer — is with the Fish and Wildlife Service. The stated purpose of the committee is "to provide for the carrying on of cooperative surveys and studies of conditions of national and interstate concern affecting conservation, wildlife, and recreational interests in the Upper Mississippi River—." And the committee has done just that, with special emphasis on the sport and commercial fisheries of the river and has published a mimeographed proceeding of work done each year since its beginning.

In 1956 it was decided to intensify the work on the river and obtain closer coordination of the projects carried out separately by states or jointly by adjacent states. Some aspects of the work were set up as special studies of 2-year duration, others, such as coordinated gathering of commercial fishery statistics, are continuous.

Although the committee's interests extend from St. Paul, Minnesota to Caruthersville, Missouri, the bulk of the work is carried on from Lock and Dam 2 at Hastings, Minnesota to just below Lock and Dam 26 at Alton, Illinois. Mostly because of pollution, there is little commercial or sport fishing done above or below these points. However, the committee is vitally concerned with these stream sections also and is active in the field of pollution survey and abatement through its Pollution Subcommittee and its cooperating agency, the U. S. Public Health Service.

Although the river fishery is the prime responsibility of the Fish Technical Subcommittee, several other phases of river activi are also receiving increased attention in th over-all program. These include access su vey and development, recreational evaluatio law enforcement and, as has been stated, po lution studies. States, several Federal agencie conservation clubs, local governments ar municipalities are involved in the access ar public-use-area program. A Law Enforceme Subcommittee was recently formed to fill void which had existed in committee activiti Conservation agents maintain close contact wi the public and should be well informed abo the committee's program, since they are in good position to both gather and dissemina important information. The law enforceme officials are also able to provide substanti aid in the important phase of the progra dealing with reciprocity and uniformity of fis ing regulations.

The work of the UMRCC has attracted a tention in other localities where cooperati studies would be of great value. At prese there is a cooperative study being made on t Roanoke River and another on the Ohio Riv Several others are under consideration. Repr sentatives of both studies have personally c served work on the Mississippi River and ha attended meetings of the Fish Technical Su committee and receive literature from t UMRCC.

Establishment of permanent fish sampli areas in the various habitats of the river planned in the future, primarily for the stu of fish populations and factors affecting the Minnesota is already under way in the proje having established several of these study ar in 1958. Iowa may enter the program in 19 since it has used similar techniques in so instances in the past. It is felt that all fi states will be active in this type of progr in the near future, as they all agree in pr ciple as to its necessity and the manner of co ducting the program. Quite naturally, the pi program in Minnesota will be followed v closely and with great interest by all conce ed. It is of great importance that the resu of such studies by the several states be co parable and at the same time geared to t needs and capacities of the states.

Studies to date indicate that the sport fishing harvest of most species of river fishes is light and that most populations could stand greatly increased fishing pressure without damage. This is heartening because of the growing need for additional recreational opportunities for people of the Midwest. To help alleviate this situation the committee is encouraging greater recreational use of the Upper Mississippi and is accomplishing this by means of the access development program, use of publicity and education media and development of a top grade Mississippi River Recreation Guide. Studies have been and are continuing to be made to determine recreational and economic values of the river resource.

Knowledge of conditions in the Upper Mississippi River is still in an elemental stage. A stream of this size and character, especially within the channelized section, offers a variety of habitats and other variables, making study and interpretation of findings very difficult. There are some evidences of discrete populations within species, even within the navigation channel areas. That there is need for basic research and for a continued investigational program is evident. There are definite habitat changes taking place—some, such as silting of impoundments, are occurring at a rather rapid rate. Old Man River presents a biological challenge of no small consequence.

ROBERT C. NORD

U. S. Fish and Wildlife Service,
La Crosse, Wisconsin

Legal Status of Fish-Impaling Devices

Taking of fish by impaling devices—spear, leister, and harpoon — is an ancient American Indian fishing method. In aboriginal times the leister, a handled device tined with barbed side-prongs for grasping the fish, was used from New England and the Great Lakes region northward, and in Alaska and western Canada southward to the Columbia River basin. The simple spear was most used in eastern United States and west-central Canada. The harpoon (defined as a spear with a detachable head) was used in northern, and especially coastal, waters across the continent and along the west coast as far south as southern California. Primitive Indian methods of using impaling devices varied, but spearing in streams during fish runs, spearing through the ice from a darkened shelter, and spearing in open water with a flare are all ancient methods.

Fishing by impaling devices has many modern devotees and as a sportfishing method has an attraction all its own. In Minnesota alone in 1957 there were 50,534 fishermen licensed to use the spear from a dark house. Sturgeon spearing through the ice is a popular specialized sport on Lake Winnebago in Wisconsin. In addition to older types of spearing and gigging (as hand impaling is usually called in the southern States) there, has been, in recent years, increased interest in use of underwater impaling devices, such as spring- and gas-driven spear guns, and in bow-and-arrow fishing. This interest has resulted in changes in fishing legislation and regulations.

To determine the present legal status of impaling devices in the several States and Provinces, a questionnaire was sent to fisheries officials in June, 1958. Replies were received from 47 States and 8 Provinces.

Use of impaling devices of some kind or kinds was reported to be legal, with various local restrictions, in 42 of the 47 States and in 6 of the 8 Provinces reporting, as follows:

Gear or method legal in:	States	Provinces
Spearing or gigging in open waters	38	4
Spearing through ice	12	3
Underwater impaling	31	5
Bow-and-arrow fishing	25	1
Harpoon	4	1
Crossbow	1	

There are many special restructions. Several States prohibit spearing in trout waters and in several the use of powered (gas or spring driven) spear guns is illegal. Louisiana requires a barbless spear for flounders. A pitch fork is legal fishing gear in agricultural Illinois. Poisoned arrows are prohibited for fishing in Virginia. Crossbows are illegal in Ohio and Virginia but legal in Missouri. New Hampshire and Georgia require that a line be attached to any arrow used for fishing. Twenty-seven States and 5 Provinces allow impaling State- or Province-wide for one or more species—usually non-game fish. Others restrict such fishing to certain waters.

In 35 States and 4 Provinces the taking of fish by impaling device is limited to "rough", "non-game", "coarse", "commercial" or "marine" species. Four States and 3 Provinces allow impaling (subject to various local restrictions) of some species of fish ordinarily considered to be "game fish". They are Michigan, Minnesota, Vermont, Wisconsin in the United States, and British Columbia, Newfoundland (which has no special restrictions on impaling devices), and Quebec in Canada.

JOHN B. MOYLE

Minnesota Department of Conservation, St. Paul, Minnesota

SEXUAL MATURITY OF HADDOCK

Collections of haddock (*Melanogrammus aeglifinus*) were made in March of 1949 and 1950 on Georges and Browns Banks to determine relationship of sexual maturity to age and length. The specimens were captured with otter trawl by a commercial trawler in 1949 and by the Fish and Wildlife Service vessel *Albatross III* in 1950. The sampling locations are shown in Figure 1. In all, 248 haddock were taken from Georges Bank and 129 from Browns Bank. Measurements are expressed in terms of fork length recorded "to the centimeter below" (requiring a correction of +0.5 to attain the true midpoint of each centimeter interval). Ages were determined from scale examinations with February 1 being used as the birth date for haddock on both banks. The data are given in Table 1.

FIGURE 1.—Areas of Georges and Browns Banks from which haddock were taken for maturity study.

The determinations of maturity were based upon gross examination of gonads. Since gonads of mature fish of both sexes enlarge greatly (about 10 times) prior to spawning, and the observations were made during the spawning season, no difficulty was experienced in distinguishing mature from immature fish. On Georges Bank both sexes were found to be fully mature at Age IV. Males were mature in higher proportions than females at Ages II and III. Length, rather than age, apparently determines maturity in the 3-year-old females. All the smaller females were immature, and all the larger ones were mature, the difference in average length amounting to 7 centimeters. There was a sudden attainment of maturity at 37 to 38 centimeters in the 3-year-old females examined.

TABLE 1.—*Age and length in centimeters of Georges Bank and Browns Bank haddock, March 1949 and 1950*

Age and maturity	Georges Bank N	Georges Bank Length in cm. Range	Georges Bank Length in cm. Mean	Georges Bank Percentage mature	Browns Bank N	Browns Bank Percentage mature
2-year-old ♀	35				3	
immature	35	27-38	33.4		3	
mature	0	—	— —	0	0	0
2-year-old ♂	38				2	
immature	29	29-40	35.7		2	
mature	19	28-39	33.7	40	0	0
3-year-old ♀	44				3	
immature	10	31-38	34.9		3	
mature	34	37-49	41.9	78	0	0
3-year-old ♂	45				1	
immature	1	47-	— —		1	
mature	44	31-49	37.5	98	0	0
4+-year-old ♀	57				62	
immature	0	—			6	
mature	57	42-70	53.6	100	56	*93
4+ year-old ♂	19				58	
immature	0	—			0	
mature	19	40-60	52.1	100	58	100

*Percentage maturity by years: 4 years, 60; 5 years, 100; 6 years, 92; 7 years, 90; 8-9 years, 100.

The attainment of maturity in males was more closely associated with age. Thus all 3-year-old male haddock of 30 to 40 centimeters' length were mature but less than half of the 2-year-old haddock of the same lengths were mature. All of thirty 1-year-old haddock examined, of both sexes, were immature.

On Browns Bank, male haddock attained maturity at 4 years of age. Female haddock were beginning to mature at Age IV, and all were mature at about Age V.

Thompson (1939) gives the percentages of Newfoundland haddock (both male and female) reaching maturity as follows: none at Age II, 15.5 at Age III, 44.5 at Age IV, 95.0 at Age V, and all mature at 6 years or over. Thompson (1929) states that Iceland haddock mature at 4 to 6 years, mostly at 5 years. Thompson (1923 and 1927) also reports from a study of North Sea haddock that about half the number of both sexes are mature at 2 years and practically all at 3 years. More extensive maturity data for North Sea haddock are given by Raitt (1936). These data, shown in Table 2, generally agree with Thompson's findings but show that males in the North Sea reach maturity earlier than females.

TABLE 2.—*Age and percentage maturity of North Sea haddock*

[From Raitt, 1936]

	Percentage mature at given age				
Age in years	2	3	4	5	6 and older
Males	60	95	99	100	100
Females	10	75	95	99	100

The age at first maturity for Georges Bank haddock is similar to that for North Sea haddock, but the limited information from Browns Bank suggests that these fish may be somewhat later in maturing and in this respect resemble the Iceland and Newfoundland haddock.

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JOHN R. CLARK

Bureau of Commercial Fisheries
Biological Laboratory
Woods Hole, Massachusetts

TRANSACTION ON MICROCARD

The earlier Volumes of the Transactions, Volumes 1-34 (1872-1905) inclusive, are now available in Microcard reprint form for $70.00 from Microcan, Inc., 618 Parker Street, Boston 20, Massachusetts.

Note on Food of Northern Log Perch

As part of a study of food habits of the walleye and associated fishes in Lake Vermilion, a large rocky-shored soft-water lake in northeastern Minnesota, stomach contents of 116 northern log perch (*Percina caprodes semifasciata*) were examined. These specimens had an average length of 2.5 inches and an average weight of 3.5 grams and were taken in hauls of a 30-foot bobbinette seine on the few gravel and sand beaches that are suitable for seining. Here they were associated with walleye fingerlings, small perch, other darters, sculpins, trout perch and fingerling largemouth and smallmouth bass.

Food studies of the Ohio log perch (*P. c. caprodes*) from Lake Erie (Ewers, 1933) and Buckeye Lake, Ohio (Ewers and Boesel, 1935) show about two-thirds of the food to be microcrustacea. However in Lake Vermilion during the summers of 1957 and 1958 the bulk of the food of *P. c semifasciatus* was aquatic insects—primarily chironomid larvae with a few mayfly nymphs. By volume such insects made up 69.8 percent of the stomach contents in 1957 and 60.5 percent in 1958. In these same years microcrustaceans made up 5.5 and 14.9 percent; larger crustacea (*Hyallela* and *Cambarus*) 7.0 and 8.9 percent; and annelid worms and unidentified eggs and other material and a single small walleye comprised the remainder of the stomach contents of the 116 fish examined.

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JOHN DOBIE

Minnesota Department of Conservation
St. Paul, Minnesota

Errata In Volume 88, Number 1

Dr. Louis A. Krumholz is associated with the *University of Louisville*, not the University of Kentucky. Dr. 1. B. Byrd is the present Chairman of the Southern Division and Mr. John Funk the present Chairman of the North-Central Division.

Eighty-eighth Annual Meeting of the American Fisheries Society

PHILADELPHIA, PENNSYLVANIA
SEPTEMBER 8 - 19, 1958

AGENDA

Monday, September 8

Morning: Call to order by the President; Presidential Address by Dr. H. S. Swingle; determination by the Secretary-Treasurer that a quorum was present; presentation of guests; welcoming Address by Mr. A. M. Goddard in behalf of the Honorable George M. Leader, Governor of the Commonwealth of Pennsylvania, entitled "Recreational Opportunities in Pennsylvania"; appointment of Sessional Committees by the President; report of Secretary-Treasurer; report of Membership Committee; action on nominations for membership; report of Finance Committee; report of Librarian; report of Chairmen of Regional Divisions and Standing Committees.

Afternoon: Panel symposium on Future Fish Culture presented by Arthur M. Phillips, Keen Buss, Carl D. Riggs, Warren J. Wisby, and David C. Haskell; with A. V. Tunison as moderator. Panel symposium on Marine Fisheries presented by L. M. Dickie, Edward Chin, Leslie W. Scattergood, Milner B. Schaefer, and W. F. Thompson; with C. P. Idyll as moderator. Vice President W. Mason Lawrence presided.

Tuesday, September 9

Morning: Address by Dr. Marcel Huet of Belgium on fluvial habitats of Western Europe; presentation and discussion of papers.

Afternoon: Presentation and discussion of papers; concluding Business Session, continuance of report of Finance Committee, reports of Sessional Committees, election of Officers, installation of new President and other Officers; concluding business.

Wednesday, September 10

Morning and Afternoon: Trips to Delaware River and Bay, Tuckahoe Waterfowl Management Area, Brandywine Valley, Wharton Woods, and Valley Forge National Park.

Evening: Annual Banquet, Crystal Ballroom, Benjamin Franklin Hotel, held jointly with International Association of Game, Fish and Conservation Commissioners.

BUSINESS SESSIONS

Opening Business Session

The Eighty-eighth Annual Meeting of The American Fisheries Society convened in the Crystal Ballroom of the Benjamin Franklin Hotel, Philadelphia, Pennsylvania on Monday morning, September 8, 1958. The meeting was called to order by President Homer S. Swingle who, after preliminary remarks, presented the Presidential Address entitled "Careers in Fisheries." A quorum was determined to be present by the Secretary. Guests were introduced, including Mr. Prida Varnasut and Mr. Umpal Pungsuwana of Thailand, Mr. Hasanudin Saanin of Indonesia and Mr. Ichiro Yamanaka of Japan. The welcoming address, "Recreational Opportunities in Pennsylvania," was presented by Mr. A. M. Goddard who spoke on behalf of the Governor of the Commonwealth of Pennsylvania.

President Swingle then appointed Sessional Committees as follows: *Nominating Committee*—A. V. Tunison, *Chairman,* Robert Jenkins, Gustav Prévost, Robert Butler, and John F. Dequine; *Time and Place Committee*—J. H. Aldrich, *Chairman,* Peter Tack, Albert Hazzard, Minor Clark, and Saul Saila; *Publicity Committee*—Edwin Cooper, *Chairman,* Edward Hueske, and Clifford Ruhr; *Auditing and Finance Committee* — Edward Schneberger, *Chairman,* Raymond Johnson, and Richard Stroud.

Secretary Seaman presented the *Secretary-Treasurer's Report,* giving in detail the financial status of the Society. Improvements in office procedure inaugurated by the Secretary during the past year were described. Equipment acquired included a Kardex membership file and addressing system, an adding machine, a supply cabinet, and several smaller office items. Mr. Seaman reported that five newsletters had been issued since the last meeting. It was moved by Mr. Seaman that the report be accepted, seconded by Mr. John Dequine, and carried. President Swingle commented on the excellent job done by the Secretary during the year.

Mr. Seaman then reported on the status of the Society's membership and commented on the fine work done during the year by the *Membership Committee* headed by Vice President W. Mason Lawrence. During the year the membership was increased by 239 Active Members, 3 Life Members, 9 Sustaining Members, 6 Library Members, and 11 Official Members; for a total membership increase of 268. Four old members were also reinstated. Thirteen members resigned from the Society, principally because they were leaving fisheries work, and there were six deaths. Attention was called to the serious financial problem caused by a large number of members being in arrears on their dues: in all 130 members were in arrears for one year and 99 for two years. It was moved by the Secretary that the 272 new applicants for membership be accepted into the Society, seconded by Mr. Seth Gordon of California and passed unanimously.

President Swingle then called for the Report of the *Finance Committee.* The majority report was presented by Dr. Edward Schneberger and a minority report by Mr. Richard Stroud. Discussion and voting on these reports (of which copies were available) was deferred until the concluding business meeting to allow members time for study and consideration of the proposals made.

Dr. Kenneth Carlander, in the absence of Librarian Dr. Howard Tanner, then presented the *Report of the Librarian.* Dr. Carlander moved adoption of the report, seconded by Dr. John Moyle of Minnesota, and carried.

Reports of Chairmen of Regional Divisions were then called for by President Swingle.

Mr. Eugene Surber of Georgia reported on the last meeting of the *Southern Division* as follows:

> At our last meeting at Mobile, Alabama, of the approximately 350 members of the Southern Division, 84 members were present. I. B. Bird in the Alabama Game and Fish Department went all out to provide an excellent program and entertainment.
>
> We had three technical, all-fisheries sessions that were very well attended. Fifty-four members were present at the business meeting. The chairman of a *Committee to consider the establishment of a Register of Professional Fisheries' biologists,* Charles Bower, gave a report at the meeting and a resolution was passed to forward that report on to the parent Society, and this report was forwarded in November. Another resolution which passed looking toward the more rapid publication of the papers of the Southern Division members and was forwarded to the Society.

There are approximately two million acres of reservoirs in the southeastern states, and the Division felt that we should have a *Reservoir Committee* to consider co-ordinative approach to reservoir problems. To this end, they asked me to appoint a *Reservoir Committee* and this I did with Jack Chance of TVA as chairman.

We had two very successful meetings, one on February 17 and another on August 26th at Atlanta. This committee has two reports which interested members may obtain upon request.

I think that concludes the report. I have one other thing. We feel that pollution is important in the South as elsewhere, and I received authorization last night to appoint a subcommittee or to establish a subcommittee in the Southern Division. We will have to do this by amending our bylaws.

Mr. Edward Kinney of West Virginia reported for the *Northeastern Division* as follows:

I have a one-sentence report here. The annual meeting of the *Northeastern Division* of the American Fisheries Society will meet at Willoughby Park, Wheeling, West Virginia, April 19 through 22, 1959.

The following report for the *Western Division* was presented by Mr. Lou Garlick of Oregon.

The *Western Division* of the American Fisheries Society held its annual meeting in Sun Valley, Idaho, in conjunction with the 28th annual meeting of the Western Association of Game and Fish Commissioners on June 23, 24 and 25, 1958. The Fisheries technical sessions of the program were arranged by the Western Division of the Society. Attendance at the technical sessions was greater than at most pervious meetings and exceeded one hundred members.

The quality of the papers presented and subsequent discussions was outstanding. This fact is borne out by the large attendance at both afternoon sessions.

New officers were elected to carry on the business of the Society and they were as follows:

Roy E. Barker of the Department of Fish and Game in New Mexico; Robert McMynn of the British Columbia Game Commission, Vancouver, British Columbia; and Cliff Millenbach of the Washington Department of Game, Seattle Washington.

The past chairman has finally been retired to pasture after six years serving in the various offices.

One item of business at the business meeting that should be brought to your attention is this, and I read it from the minutes of the business meeting: "It was evident that some method to permit more active participation by members on matters discussed at annual meetings be developed. This discussion culminated in a motion by John Rayner that the chairman advise the Parent Body that members of the Western Division strongly favored the use of a post card or similar ballot as a means to express their feelings in regard to matters affecting the operations of the organization and that the determination of the matters polled would be the discretion of the Executive Committee of the Parent body. The motion was seconded by George Holton and approved."

Now, the attendance at the annual meetings of the Western Division continues to grow. Last meeting, technical session, had the largest attendance in several years. Our annual meetings are providing a major opportunity for fishery workers over the Western states to get together to exchange ideas on our many common problems.

The program emphasis in the Western Division has been upon panel discussions of timely subjects of common interest, and I might comment on some of those subjects. We had a very interesting panel discussion on the integration of the hatchery program in fishery management including the viewpoint of the biologist, the viewpoint of a hatcheryman, and the viewpoint of an administrator.

We had another very interesting panel on basic research, its administration and application.

In conclusion I should like to say that the Western Division is serving a worth-while purpose and is in healthy condition.

Dr. Kenneth Carlander of Iowa then reported for the *North-Central Division*:

The annual meeting of the *North-Central Division* last year, chairmaned by Ed. Schneberger, was held in Milwaukee, Wisconsin, December 9 and 10 in connection with the Midwest Wildlife Conference. There was an excellent series of technical sessions on fisheries. The major activity of the North-Central Region has been the preparation and distribution of a Newsletter to keep the members of the Society better informed and better acquainted.

The most recent issue of the Newsletter appeared about a month ago. Out next meeting will be December 15 this year in connection with the Midwest Wildlife Conference which is December 15 to 17 in the Neil House, Columbus, Ohio. This meeting will be close to the Northeast and to the Southeast regions, and we would like to extend welcome to any of you who can come.

After an intermission, the *Report of the Editorial Board* was presented by Editor John Moyle. He moved the report be accepted, seconded by Mr. Fred Dixon of Georgia, and carried.

Dr. Reeve M. Bailey of Michigan then presented the *Report of the Committee on Names of Fishes,* and moved its adoption. It was seconded by Mr. Eugene Surber and carried.

Dr. Clarence Tarzwell presented the *Report of the Committee on Water Pollution* and moved its adoption. It was seconded by Mr. Richard Stroud and carried.

Mr. D. L. McKernan next presented the *Report of the Committee on Commercial Fish-*

eries in the form of a series of slides showing recent developments in this field of fisheries activities. He moved its adoption, seconded by Mr. Idyll of Florida and carried.

The *Report on Hydrobiology and Fish Culture* was presented by Dr. F. E. J. Fry of Ontario who pointed out that the work of the Committee consisted of production of a leaflet on fish diseases by Dr. Stanislaus Snieszko of West Virginia; a study of effectiveness of trout stocking by Mr. Joseph Wales of California, and work by Dr. Harry Everhardt of Maine on physiology and transportation of fish. Dr. Fry moved adoption of the report, seconded by Dr. Carlander and carried.

President Swingle then called for the *Report on National-State Relations.* It was presented by Dr. Leo Shapovalov who moved its adoption. It was seconded by Dr. Clarence Cottam of Texas and carried. Committee reports were concluded with the presentation of the *Report of the Committee on International Relations* by Mr. Leslie W. Scattergood of Maine, in the absence of Mr. M. C. James. He moved its adoption, seconded by Mr. Thomas Dolan of Pennsylvania and carried. After some announcements by President Swingle, the opening business meeting was adjourned at 11:55 a. m.

Concluding Business Session

The concluding business session convened in the Crystal Ballroom of the Benjamin Franklin Hotel at 3:30 P. M. on Tuesday, September 9, 1959. President Swingle presided and called for the *Report of the Auditing Committee.*

Dr. Edward Schneberger reported that the *Auditing Committee* had examined the accounts of the Society as well as the audit of them prepared by Howard C. Haire, Certified Public Accountant, and was satisfied that the accounts are correct and all monies properly accounted for. The *Auditing Committee* reported that the Secretary-Treasurer had in his posession a large accumulation of financial records from many previous years and that these were taking up valuable space and have no apparent value. It was recommended that the Secretary-Treasurer be authorized to dispose of outdated records in accordance with the laws governing the keeping of legal and financial records in the area where the Society was incorporated. Dr. Schneberger moved acceptance of the report, seconded by Mr. Stroud and carried.

Vice President W. Mason Lawrence then reported on nominations for *Honorary Membership* in the Society. He pointed out that Article 2 of the Constitution provides that nominations for honorary membership shall be accompanied by endorsement of at least ten active members of the Society in good standing and that an unanimous vote at the Annual Meeting is required for election. Mr. Lawrence then presented the first nomination:

> The first nomination is of Dr. A. G. Huntsman. Dr. Huntsman has been an active member of our Society for 45 years and has served it with great distinction and has made significant contributions to it. He is a former president of this Society. He has a long and distinguished career, and for a long time was associated with the University of Toronto where he was a lecturer in biology from 1907 to 1916, and Associate Professor in Marine biology from 1917 to 1927, and a Professor of Marine Biology from 1927 to 1954.
>
> Dr. Huntsman is retired but still associated with the Zoological Department of the University of Toronto and the Atlantic Biological Station, St. Andrews, New Brunswick.
>
> Mr. President, the Secretary has certified to me that this nomination carries the endorsement of ten active members in good standing. I therefore move the election of Dr. A. G. Huntsman to honorary membership.

The nomination was seconded by Dr. W. H. K. Harkness of Ontario and carired unanimously.

Mr. Lawrence then presented the nomination of Mr. Elmer Higgins for Honorary Membership:

> The second nomination is that of Mr. Elmer Higgins. As was the case with Dr. Huntsman, it will be impossible in any reasonable time to cite the many contributions that Mr. Higgins has made to our field. The nomination is made in recognition of his long and distinguished career in the field of fishery, biology and administration, and his participation in the affairs of the Society for most of the years in a very active manner since 1933. His numerous original treatises and his leadership in establishment of the Progressive Fish Culturist represent notable contributions to the advancement of the theory and practice of fishery science. Mr. Higgins' career with the Fish and Wildlife Service and its predecessor agency, the Bureau of Fisheries, over nearly 34 years has indeed been a distinguished one.
>
> Mr. President, the Secretary has certified to me that the nomination of Mr. Elmer Higgins for honorary membership carries the endorsement of ten active members in good standing. I therefore move the election of Mr. Elmer Higgins to honorary membership in the American Fisheries Society.

The motion for nomination of Mr. Higgins was seconded by Mr. Charles Hayford of New Jersey, put to vote and carried unanimously.

President Swingle declared Dr. Huntsman and Mr. Higgins elected to Honorary Membership of the American Fisheries Society.

President Swingle then called for consideration of the majority and minority reports of the *Finance Committee* which had been presented at the first business session. Dr. Schneberger, *Chairman of the Finance Committee,* asked that the question of dues be considered first and after presenting the following motion regarding proposed dues:

> On the basis of the results of the poll of the membership and the general feeling of people that I have discussed the matter with briefly, and also for fear of not losing too many members, I feel that we must stick to the majority recommendation of the ten dollar dues for active members.
>
> Therefore, I move that the dues to take effect for the current fiscal year, 1958-59, be as follows:
>
> | | |
> |---|---|
> | Active members | $10.00 |
> | Student members | 5.00 |
> | Foreign members | 5.00 |
> | Sustaining members | 20.00 |
> | Library members | 5.00 |
> | Official members | 40.00 |
> | Life members | 125.00 |
>
> Also in my motion is that the life member dues are payable in three annual consecutive payments, if so desired, with a penalty clause of $5.00 if a person fails to pay in one year.

Dr. Schneberger's motion was seconded by Dr. Raymond Johnson of Washington, D. C. In the discussion following, Mr. Stroud stood on the recommendation of the minority report and offered an amendment that dues for Active Members be increased to $15.00 to provide for an Executive Secretary at a salary of not less than $8,500.00 per annum. The amendment was seconded by Mr. Roland Smith of New Jersey. After considerable discussion as to possible effect of increased dues on membership, the proposed amendment was put to a vote and voted down, 57 for and 64 against. Dr. Raney of New York then moved to increase dues for Library Membership to $10.00 and pointed out that many more library subscriptions could probably be obtained, since this has been the experience with *Copeia.* However, special reduction of rates might have to be allowed to subscription agencies through whom many libraries obtain their periodicals. Dr. Raney's motion was seconded by Dr. Carlander, put to vote and passed. Dr. Raney then moved that the *Finance Committee Report* be amended so that dues for Life Membership be $200.00, payable in four installments of $50.00 each. This motion for amendment was seconded by Mr. Stroud, put to vote and carried. Mr. Briggs moved that the proposed Student Membership of $5.00 be extended personnel serving in the armed forces. The motion was seconded by Dr. Raney. Because the motion was in conflict with the Constitution of the Society in the form presented, it was restated by Dr. Ralph Hile: "to allow the rate of $5.00 per annum to active members during their period in the armed services, for two years." The motion for the amendment was seconded by Mr. Briggs, put to a vote and carried.

President Swingle then called for a vote on Dr. Schneberger's motion as amended as follows:

Active members	$ 10.00
Student members	5.00
Foreign members	5.00
Sustaining members	20.00
Library members	10.00
Official members	40.00
Life members	200.00
Military members while in the armed forces for 2 years	5.00

A vote was taken and the motion carried.

Dr. Schneberger then took up consideration of quarterly publication of the TRANSACTIONS and made the following motion: "It is moved that the Society issue a quarterly journal, provided that the *Executive Committee* find that there are sufficient funds available, and that the *Editorial Board* has necessary assistance to insure the prompt and regularly scheduled publication of a quarterly journal without sacrificing quality or lowering standards."

The motion was seconded by Mr. Webster. In discussion it was brought out that the quarterly would be one Volume of four separate Numbers issued at regular intervals during the year and that it would provide more publication space than the annual volume. Editor Moyle pointed out that to make use of this space more papers would have to be submitted for publication. He remarked that all of the good papers submitted for annual Volumes 86 and 87 had been published, and that publication cost for the Annual Volume was about

$11.00 a page. Mr. Gottschalk of Virginia expressed himself in favor of a *bona fide* professional journal rather than one primarily reporting the Annual Meeting. Mr. Verne Joslin of Minnesota pointed out that a quarterly journal could be expected to cost more than a single annual because of additional binding, mailing and other costs. Mr. Hayford commented that in the early 1920's quarterly publication of the TRANSACTIONS had been tried and then given up.

The motion proposing publication of the TRANSACTIONS as a quarterly was reread by President Swingle and put to a vote. It carried.

President Swingle then called for a report by the *Resolutions Committee.* Resolutions No. 1 through 11 were presented by Mr. Harry Cornell of North Carolina and No. 12 through 16 by Mr. John Gottschalk of Virginia.

Resolution No. 1—Publication of the Transactions

WHEREAS, there is an increasingly large number of excellent papers on fisheries subjects produced each year, and,

WHEREAS, it is impossible to include a majority of these papers in the TRANSACTIONS of the American Fisheries Society, because of the limitations of available space; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that provision be made for the possibility of semi-annual or quarterly issues of the TRANSACTIONS by changing Section 6 of the Bylaws to read as follows: " . . . shall be published in an annual volume which shall be numbered in series with the preceding volumes, which may be printed in one or more issues throughout the year, and which shall be entitled . . ."

Adoption of the resolution was moved by Mr. Cornell and seconded by Mr. Willis King of Washington, D. C. An amendment was offered by Dr. Eicher of Oregon, that the title of the quarterly publication be called: "The Journal of the American Fisheries Society," but failed for want of a second. The resolution was put to a vote and carried.

Resolution No. 2—Mail Ballots

WHEREAS, the membership of the American Fisheries Society numbers approximately 2,000 at the present time, and,

WHEREAS, the business meetings of the Society are attended by a relatively small part of the total membership, and,

WHEREAS, the entire membership should have a voice in determining policies and activities of the Society; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that the President appoint an *ad hoc* committee to study the feasibility of the extended use of mail ballots; this committee to report its findings and recommendations to the 89th meeting of the Society.

Adoption was moved by Mr. Cornell and seconded by Dr. Tunison of Washington, D. C. Mr. Gottschalk, a member of the Resolutions Committee, pointed out that several committee reports on the subject of mail ballots have been made in the past and this resolution may result in a duplication of work already done. The resolution was put to a vote and lost.

Resolution No. 3—Finance Committee

WHEREAS, the financial affairs of the American Fisheries Society have become increasingly complicated as a result of the growth of the Society, and,

WHEREAS, the Executive Committee and officers of the Society desire guidance in the administration of the financial affairs of the Society; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that a standing committee to be called the "Finance Committee" shall be created by changes in the Bylaws of the Society as follows:

1. Add a new section of the Bylaws, appropriately numbered, and entitled "Finance Committee," to be defined as follows:

"The Finance Committee is a standing committee, responsible for the promotion and improvement of the finances of the Society, which shall consider the annual budget prepared by the Secretary-Treasurer with the advice of the Executive Committee, and which shall make recommendations concerning finances for action by the membership.

"The Finance Committee shall make annual recommendations concerning the management of the funds of the Society and shall, from time to time, conduct studies, as needed, of financial matters related to revenues and disbursements.

"The committee shall be composed of three members in good standing who are recognized for their business acumen, and who shall be named by the nominating committee and elected by the membership. There shall be a carry-over of at least one member of the committee at each election."

2. Change Section 19 (c) by inserting a period after the first use of the word Society, and strike out the remainder of the sentence.

The second change is designed to remove the budgetary considerations from the work of the Auditing Committee.

Mr. Cornell moved its adoption and at President Swingle's suggestion offered the following explanation: the Bylaws at present provide for a sessional committee called the Auditing Committee. That committee in addition to auditing the accounts of the Society is charged with the responsibility of budgetary considerations. It is believed that the budgetary considerations which are of importance all dur-

ing the year and are of continuing interest in the welfare of the Society, should be considered by a committee with no other responsibilities but that, and that it is improper to ask the Auditing Committee, a sessional committee to be concerned and advise the members on budgetary considerations. That is the purpose of recreating the Finance Committee as a standing committee.

The motion for adoption of Resolution No. 3 by Mr. Cornell was seconded by Mr. John Gottschalk, put to a vote and carried.

Resolution No. 4—Membership and Dues

WHEREAS, an increase in fees may be expected to work an undue hardship on some of our active membership; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that the following changes be made in the Constitution and Bylaws of the Society:

1. Change Article 2, Section 1, of the Constitution to incluude two additional classes of members described as follows:

(a) *Foreign member*: Any duly elected member, who is not a resident of the United States or Canada, who is desirous of membership in the Society at a reduced rate. A foreign member shall have all the rights and privileges of an active member except to hold an elective office. A foreign member may hold an active membership upon payment of the active membership fee.

(b) *Student member:* Any duly elected member who is a bona fide academic student of fisheries subjects, and who desires membership in the Society at a reduced rate. To qualify, a student member must be endorsed originally and annually by an active member in good standing. A student member shall have all the rights and privileges of an active member except to hold an elective office. A student member may hold an active membership upon payment of the active membership fee.

2. Change Article 2, Section 2, of the Constitution to read as follows: "Nominations for active member, foreign member, student member, sustaining member . . ."

3. Change Article 2, Section 5, of the Constiution to read as follows: " . . .; providing that only active, foreign, and student members in good standing, and life members and distinguished service honorary members shall be entitled to vote."

4. Change Section 8 of the Bylaws, effective July 1, 1958, to read as follows:

"The dues of the various classes of members, payable to the Secretary-Treasurer of the Society, shall be as follows:

(a) Active membership, $10.00, per annum.
(b) Foreign membership, $5.00 per annum.
(c) Student membership, $5.00 per annum.
(d) Life membership, $200.00, payable, if desired, in four annual installments of $50.00 with a $5.00 penalty if the annual installments are not consecutive.
(e) Library membership, $10.00 per annum.
(f) Sustaining membership, $20.00 annum.
(g) Official membership, $40.00 per annum.
(h) Patron, a single contribution of $250.00 or more.
(i) Honorary Membership, no dues.
(j) Active members, while in military service, for a period of not more than two years, $5.00 per annum.

Mr. Cornell moved the adoption of Resolution No. 4. It was seconded by Mr. Gottschalk put to a vote and carried.

Resolution No. 5—Financial Assistance

WHEREAS, the expansion of the activities of the American Fisheries Society has made the duties of some officers and committee members of the Society so onerous as to require more time and effort than members are free to contribute, and,

WHEREAS, the possibility exists of a need for the employment of editorial and secretarial assistance; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that Section 5 of the Bylaws be amended to read as follows:

"No elected officer or committee member of the Society shall receive any salary or other compensation for his services unless it has been recommended by the Finance Committee and approved by the Executive Committee. Clerical and other necessary expenses . . . "

Mr. Cornell moved the adoption of Resolution 5. It was seconded by Mr. Elser of Maryland, put to a vote and carried.

Resolution No. 6—Cooperation with Trout Farmers Association

WHEREAS, there is an expanding community of interest and activity involving the American Fisheries Society and the United States Trout Farmers Association, and,

WHEREAS, the interests of the profession and the needs of the resource demand an understanding of the scope and character of this community of interest; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that the President of the Society negotiate with the President of the United States Trout Farmers Association with a view to establishing a joint committee of the two organizations, the purpose of which would be to study and prepare a report on matters of material interest, and ways in which the two organizations may work together more effectively.)

Mr. Cornell moved the adoption of Resolution No. 6, seconded by Mr. Gottschalk, put to a vote and carried.

Resolution No. 7—Affiliation with AIBS

WHEREAS, the American Institute of Biological Sciences is an associated group of Biological Societies joined together for the purpose of stimulating the development and promoting the

welfare of biology, and,

WHEREAS, this group represents, on a national basis, one of the largest associated groups of biologists in the world, and

WHEREAS, there are more and more questions of national and international concern to the American Fisheries Society and to biologists in general, and,

WHEREAS, it is felt that for the growth and further development of our Society as a dominant factor in fisheries matters, affiliation is desirable; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that it join the AIBS as an affiliate member, looking toward the time, should it later be thought in the best interests of the Society, of applying for full membership in the American Institute of Biological Sciences.

Following an explanation by Dr. Don McKernan of Alaska of the advantages to the Society from affiliating with the American Institute of Biological Sciences (AIBS) and statement that the estimated cost to the Society of affiliate membership would be $200.00, Mr. Cornell moved adoption of Resolution No. 7. It was seconded by Mr. Eugene Surber, put to a vote and carried.

Resolution No. 8—Professional Standards Committee

WHEREAS, it is one of the basic objectives of the American Fisheries Society to foster and enhance the professional stature and economic well-being of individuals engaged in fishery activities in North America, and,

WHEREAS, one means of accomplishing these aims is through the development of professional standards; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that the President appoint an *ad hoc* committee of not less than five members, including one member from each of the regional divisions, for the purpose of investigating the need for and feasibility of the establishment by the American Fisheries Society of standards for professional fishery biologists, including the definition of the professions within the fishery field, minimum requirements of education and experience, method and extent of examination, method of registration of professional fishery workers, establishment of minimum standards for college curricular and faculties, and such related matters as the committee may deem desirable, and,

BE IT FURTHER RESOLVED, that this committee shall present its report to the 89th meeting of the American Fisheries Society.

Mr. Cornell moved the adoption of Resolution No. 8. Seconded by Mr. Gottschalk, put to a vote and carried.

Resolution No. 9—Dingell-Johnson Funds

WHEREAS, fishing and aquatic recreation are recognized as important economic resources in our nation today, and,

WHEREAS, the use of Dingell-Johnson funds by the several states has aided materially in acquisition, habitat development, and research, for increasing fishing opportunities, and,

WHEREAS, additional funds are needed by all states to properly develop the fishing resource in proportion to the demand, and

WHEREAS, the present Dingell-Johnson funds are accumulated from a tax on a very limited number of items utilized in fishing; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that the Society does strongly urge the United States Department of the Interior to propose to the Congress an Amendment to the Federal Aid in Fish Restoration Act (64 Stat. 430) to increase the number of items for fishing upon which a tax is imposed, said additional taxed items to include dipnets, fishing waders, fishing jackets and other garments for sport fishing, bait pails and containers, fishing line (casting, fly), headers and other line attachments, tackle boxes, preserved, specially treated and manufactured bait mixtures or natural baits marketed under brand names, manufactured fish stringers and fish bags, reel oils, greases, and line dressings, rod and reel cases, outboard motors of 10 H. P. and under, and boats of 14 feet and under.

Adoption of Resolution No. 9 was moved by Mr. Cornell, seconded by Dr. Edward Schneberger, put to a vote and carried.

Resolution No. 10—Memorial to Dr. H. S. Davis

WHEREAS, Dr. H. S. Davis died on July 15, 1958, in his eighty-third year, and,

WHEREAS, he was a past president, an honorary member, and one of the oldest members of the American Fisheries Society, and,

WHEREAS, his lifetime of service to the field of fishery biology, and especially to fish pathology, has resulted in his descriptions of bacterial infections such as gill disease, columnaris, and fin rot; and protozoan parasites such as Octomitus, and Trichophora, and,

WHEREAS, the results of his lifetime of work in the field of fish pathology have resulted in outstanding contributions to the etiology and treatment of fish diseases; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that Volume 88 of the TRANSACTIONS of the American Fisheries Society be dedicated to the memory of Dr. Davis by including his picture on the fly-leaf of that Volume followed by a suitable obituary.

Mr. Cornell moved the adoption of Resolution No. 10, second by Dr. Carlander, put to a vote and carried.

Resolution No. 11—Appreciation for courtesies

WHEREAS, this the 88th annual meeting of the American Fisheries Society has won acclaim as one of the best meetings held by the Society, and,

WHEREAS, credit for the success of the meeting may be attributed in no inconsequential degrees to the hospitality, congeniality, and spirit of goodwill manifested by our hosts in this the City of Brotherliy Love, and,

WHEREAS, the membership of the Society desires to acknowledge its gratitude for the favors, assistance, and hard work which have been so essential to the success of this meeting; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that we do hereby acknowledge with sincere appreciation the contributions to the success of this convention by the many individuals, and by the officials, agencies, and organizations of the Commonwealth of Pennsylvania, the State of New Jersey, and the State of Delaware.

The resolution was put to a vote and carried with loud applause.

Resolution No. 12—Recreational use of waters

WHEREAS, the need for insuring the public use of natural and impounded water areas has become acute, and will become increasingly more so as our human population soars past the 200 million mark, and,

WHEREAS, the multiple-use concept includes recognition of recreation as an important use of public outdoor resources, and,

WHEREAS, federal policy with respect to use of and access to impounded waters in federal lands for recreational purposes has not uniformly recognized the application of the multiple use concept; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that any agencies issuing permits for the purpose of water impoundment stipulate in the permit the right of the public to use such areas for recreation; and further, that any agencies impounding water on land owned by the public include provision for public recreation in water reservoirs so created, and, acquire absolute legal title to such land as may be required to foster and promote appropriate public recreational use of the impounded waters.

Adoption of Resolution No. 13 was moved by Mr. Gottschalk, seconded by Mr. Marion Toole of Texas, put to a vote and carried.

Resolution No. 13—Protection of anadromous fishes

WHEREAS, the anadromous fishery resources of North America constitute one of the continents' most priceless heritages, and,

WHEREAS, in the United States the development of many rivers for hydroelectric power generation and other purposes necessitating the construction of dams impassable by anadromous fishes has placed these resources in jeopardy, and,

WHEREAS, recent decisions of Federal courts have divested the States of the right to protect and preserve these rivers and their indigenous fishery resources, without substituting therefore adequate Federal protection for or consideration of these resources, and,

WHEREAS, a precedent for such Federal policy exists in the protection afforded the National Parks, Forests, Wildlife Refuges, other Reservations and navigation projects, by the requirement of prior approval by the appropriate Cabinet members, of river development proposals which affect such areas or projects, now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that the Congress enact legislation similar in purpose to Statute 3185 of the 85th Congress, which will establish in law the principle of protection for anadromous fisheries, through the requirement that the Secretary of the Interior approve plans for dams to be constructed by Federal agencies or under Federal permit on rivers of known importance to runs of anadromous fishes.

Adoption of Resolution No. 13 was moved by Mr. Gottschalk, seconded by Mr. Stroud put to a vote and carried.

Resolution No. 14—Encouragement of research

WHEREAS, the increasing pressure placed upon our sport fishery resources necessitates the fullest application of effort on the part of the States and Federal government to provide a satisfactory level of recreational fishing, and,

WHEREAS, there are many opportunities for cooperative endeavor in sport fisheries management between State and Federal agencies, and,

WHEREAS, there is need for additional information on life histories, habitat requirements, and management methods for our sport fishes—both marine and freshwater, and,

WHEREAS, insufficient funds have been appropriated for the Branches of Fishery Research and Fishery Management Services of the United States Fish and Wildlife Service to adequately develop these urgently needed cooperative programs; now, therefore.

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that the Department of the Interior, the Bureau of the Budget and the Congress of the United States, be urged to appropriate and make available to those Branches funds more nearly in keeping with the tasks assigned them and the needs of sport fishery research and management throughout the nation.

Adoption of Resolution 14 was moved by Mr. Gottschalk, seconded by Mr. King of Washington, D. C., put to a vote and carried.

Resolution No. 15—Selective fish toxicants

WHEREAS, this Society recognizes that one of the most serious problems in the management of fisheries is the control of various undesirable fish populations, and,

WHEREAS, the use of selective toxicants in eliminating specific species appears to have unlimited possibilities, and,

WHEREAS, the United States Fish and Wildlife Service has already carried out a program of testing and screening the toxicity of chemical compounds in connection with the Great Lakes sea lamprey control program and has begun the development of research facilities to continue this program for the general benefit of fishery management, now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that the Society commends the Secretary of the Interior and the United States Fish and Wildlife Service for the expansion of the program of testing selective toxicants to find additional chemicals that can be used to eliminate various species of undesirable fishes, and urges that high priority and adequate funds to prosecute the program in the most vigorous fashion be accorded this project.

Adoption of Resolution No. 15 was moved by Mr. Gottschalk, seconded by Mr. Thompson of Washington, D. C., put to a vote and carried.

Resolution No. 16—Attendance at Annual Meeting

WHEREAS, a principal benefit of the annual meeting of the American Fisheries Society is the opportunity provided for the younger fishery workers to exchange information and ideas, and,

WHEREAS, attendance at the annual meeting is frequently restricted to the administrative heads of departments, whose attendance is desirable and essential; now, therefore,

BE IT RESOLVED, by the American Fisheries Society at its 88th meeting, that the Society urge all appropriate governmental departments and institutions to recognize the unique importance of this meeting and to foster, abet, and expedite the attendance of junior personnel at the annual meeting of the Society and its regional divisions.

Adoption of Resolution 16 was moved by Mr. Gottschalk, seconded by Dr. William Ricker of British Columbia, put to a vote and carried.

President Swingle called for the report of the *Nominating Committee.* This was presented by Dr. A. V. Tunison as follows:

This year's *Nominating Committee* consisted of the following members: Gustave Prevost of Quebec; R. L. Butler of California; John F. DeQuine of Florida; Robert M. Jenkins of Virginia; and A. V. Tunison of Washington, D. C., *Chairman.* Mr. Lee S. Roach of Ohio was the original chairman of the committee but due to unfortunate illness asked to be relieved of the assignment. I should like at this time to thank Mr. Roach for the excellent work he did while on the committee. Also, I should like to thank the other committee members for their excellent cooperation.

President Swingle directed our committee to proposed candidates for the various offices and standing committees who would give aggressive leadership on their assignments. Precedence used at times in the past in making selections was not to be a major criterion. The committee has endeavored to carry out these instructions.

The Society's membership is made up primarily from the States. For this reason as well as the representation in the various offices in the recent past, the committee recommends candidates for the office of Second Vice-President from two states, one in the East and one in the Midwest. The committee recommends one name for the offices of President, Vice-President, Secretary-Treasurer, and Librarian, as follows:

President	W. Mason Lawrence, of New York
First Vice-President	James W. Moffett, of Michigan
Secretary-Treasurer	E. A. Seaman, of Virginia
Librarian	Howard A. Tanner, of Colorado
Second Vice-President	J. H. Cornell, of North Carolina Kenneth D. Carlander, of Iowa

For the six standing committees, we are proposing a single slate of nominees. In view of the excellent and continuing work of the Committee on Water Pollution and the Committee on Names of Fishes, it was suggested that they be continued with only minor change. Dr. Clarence M. Tarzwell and Dr. Reeve M. Bailey, respective chairmen of these committees, have consented to this. Dr. Bailey has called our committee's attention to one change in his committee during the year. Dr. Edward C. Raney, of New York, was unable to devote the necessary time to the assignment and asked to be relieved. President Swingle appointed as his replacement Dr. C. C. Lindsey, of the University of British Columbia.

Dr. Tarzwell advised our committee that he believed the Committee on Water Pollution should be expanded to a membership of twelve. By such enlargement the individual members would have smaller assignments and could do a more adequate job. Action on this proposal is of course

beyond the scope of authority of the Nominating Committee and has been called to the attention of the Executive Committee. We are recommending one change in the committee in order to equalize the work load assignments, geographically.

The following names are presented in nomination:

Committee on International Relations

Norman S. Baldwin, Michigan, Chairman
Garth Murphy, Honolulu, T. H.
John S. Gottschalk, Washington, D. C.
Francis Sargent, Massachusetts
Marcel Huet, Belgium
Radway Allen, New Zealand

Committee on National-State Relations

Raymond E. Johnson, Washington, D. C., Chairman
Paul H. Eschmeyer, Michigan
A. D. Aldrich, Florida
John H. Rayner, Oregon
A. E. Borell, Colorado

Committee on Hydrobiology and Fish Culture

I. B. Byrd, Alabama, Chairman
J. P. Cuerrier, Ontario
Kermit Sneed, Oklahoma
Edwin L. Cooper, Pennsylvania
Leonard N. Allison, Michigan
Leo Shapovalov, California
Paul G. Barnickol, Missouri

Committee on Commercial Fisheries

Edwin S. Iversen, Florida, Chairman
Percy Viosca, Louisiana
John W. Parsons, Michigan
Seton Thompson, Florida
James R. Westman, New Jersey
John L. Kask, Ontario
Charles R. Carry, California

Committee on Water Pollution

Clarence M. Tarzwell, Ohio, Chairman
Max Katz, Oregon
John L. Hart, New Brunswick
Eugene W. Surber, Georgia
George E. Burdick, New York
C. J. D. Brown, Montana

Committee on Names of Fishes

Reeve M. Bailey, Chairman, Michigan
Ernest A. Lachner, Washington, D. C.
C. C. Lindsey, British Columbia
William B. Scott, Ontario
Loren P. Woods, Illinois
C. Richard Robins, Florida
Phil M. Roedel, California

President Swingle then asked for any additional nominations for committee members from the floor. There were none. Mr. Gerry Wade of Maine moved the nominations be closed. This was seconded by Mr. Gottschalk, put to a vote and carried.

President Swingle then asked for any additional nominations from the floor for the offices of President, First Vice President, Secretary-Treasurer and Librarian. There were none. Dr. Tunison moved that the nominations for these offices be closed, seconded by Mr. DeQuine of Florida, put to a vote, and carried.

Committee nominees for Second Vice President then retired from the room and President Swingle asked for any additional nominations from the floor for this office. There were none. Paper ballots were passed out and a ballot taken with Mr. Henry Shafer and Dr. Reeve Bailey acting as tellers.

While ballots were being counted, Dr. Eicher moved that the by-laws be changed to make the title of the Society's quarterly "Journal of the American Fisheries Society". The motion was seconded by Mr. Stroud. Dr. Ricker commented that such a decision could be unfortunate, result in confusion, and in his opinion should not be made in haste. President Swingle called for a vote. The motion was lost.

Dr. Bailey reported that the tally of votes for Second Vice-President by the tellers showed Dr. Carlander to be elected for this office. Applause.

The newly elected President, W. Mason Lawrence, was then escorted to the rostrum by Dr. Gustave Prevost of Quebec and Mr. Roland Smith of New Jersey along with the other new officers and amid rising applause from the audience.

President Lawrence, after expressing his appreciation to the Society for honoring him as its president, called for any new business.

Mr. Gottschalk moved that Editor John Moyle and the Editorial Board be commended for prompt issuance of Volume 87 of the Transactions. *Applause.* A motion to adjourn was made, seconded and carried.

The 88th Annual Meeting of the American Fisheries Society stood adjourned at 5:35 p.m., September 9, 1958.

REPORTS OF OFFICERS AND COMMITTEES

EIGHTY-EIGHTH ANNUAL MEETING, PHILADELPHIA, PENNSYLVANIA

SEPTEMBER 8-10, 1958

Report of Secretary-Treasurer

E. A. SEAMAN

Mr. President, members of the American Fisheries Society, I submit to you my initial report as your new Secretary-Treasurer.

At the outset I first want to thank our last Secretary-Treasurer, Everett Speaker, for his kindness, courteous assistance, and helpful guidance in getting me started in handling the job of Secretary-Treasurer. Mr. Speaker continues to be helpful, and I thank him for his interest.

To past Secretary-Treasurer, George Sprecher, I wish to offer my thanks for the thoughtfulness of setting up reserve funds which have recently, as pointed out later in my financial statement, proven to be "life-savers" to the Society, being money available for "the rainy day" we just experienced the past three months.

The Society's books were audited this year by Howard C. Haire, Public Accountant, Washington, D. C. His report and a financial statement has been placed in the hands of the Auditing Committee. These will appear as a part of this report in the Transactions.

Our cash balance as of July 1, 1957 was $10,906.43. Receipts for the fiscal year 1957-1958 consisting of annual dues, dividends, and sale of publications, totalled $13,214.66. Disbursements totalled $18,002.33. This primarily included printing costs, postage, stenographic service, editorial stipend, meeting expenses, insurance and similar miscellaneous costs. The net balance on June 30, 1958 was $6,118.76.

The total estimated market value of stocks held by the Society on June 30, 1958 was $2-097.00. The current value of U. S. Government bonds, "F" and "J" series, was $8,211.50, or a total of $10,308.50 in securities on hand.

In compliance with the recommendation of our Special Finance Committee, under the chairmanship of Edward Schneberger, the Secretary cashed U. S. Government bonds to cover expenses approved by the Society at the Las Vegas meeting. A total of $4,147.00 was obtained from cashing five bonds, and these funds were deposited in the account of the Society on August 5, 1958.

For further details on the financial status of the Society, rather than take the time to present details, may I suggest to those who wish to scrutinize this further, we have copies of the full accounting prepared and available here at the rostrum.

At the last annual meeting a new course was taken in the operation of the Secretary-Treasurer's office. In lieu of using gratis help of state agencies, a stenographer was hired at Arlington, Va., to handle the clerical work of the Society. Certain equipment was purchased, namely an adding machine, a stationery supply cabinet, a Kardex Membership File system, and a few small office items. These purchases were approved by President Swingle, and certain major innovations, such as the Kardex system, were approved by the Executive Committee at St. Louis.

May I point out at this time that the Secretary is not wishing to instigate changes merely for making changes. This Kardex system cost $700.00. It should be usable for 20 years. This modern ready-reference membership record system is actually costing the Society but $35.00 per year, based on a projected life use. It saves many hours of clerical time, also.

The Secretary has issued five (5) Newsletters since the last annual meeting. As far as can be determined, based on letters and personal comments, these periodic Newsletters are meeting with the general approval of the membership.

The Secretary is open to suggestions regarding the content of the Newsletters, as well as the operation of the office and details in handling the business of the Society. The Secretary wishes to be as helpful and provide as

many services as possible under a modest financial cost involved.

A proposed budget for the next year has been submitted to the Executive Committee which met last evening. This is available for review.

In closing I wish to express my sincere thanks to the officers of the Society for their support and prompt assistance many times throughout the year. I have been privileged to serve such fine officers.

AMERICAN FISHERIES SOCIETY
ANNUAL FINANCIAL REPORT

For the Fiscal Year July 1, 1957 to June 30, 1958

*Cash Receipts included checks returned to deposited by bank.

**U. S. Government Savings Bonds certificate numbers M1610061F, M1773328F, M1773329F, M1773330F, and M208433J were cashed June 30, 1958. The cash received was deposited in the checking account in July 1858.

***A 2-for-1 split of the common stock of Central Illinois Light Company was effective as of March 28, 1958.

Cash Balance as of July 1, 1957		$10,906.34
Receipts:		
Membership Dues:		
a. Active	$ 9,226.80	
b. Official	1,600.00	
c. Library	520.55	
d. Sustaining	360.00	
Other:		
Sale of Transactions and Special Publications	1,412.80	
Dividends, Stock	98.40	
Refund on Surety Bond	19.50	
Miscellaneous	1.61	
Total Receipts	$13,239.66	
*Less Returned Checks	25.00	
Net Receipts		13,214.66
Net Receipts		13,214.66
Total	*	$24,121.09
Disbursements:		
Printing Expense	$13,857.06	
Postage and Office Supplies	543.78	
Petty Cash	200.00	
Reprinting Volume 86 of Transactions	351.32	
Stenographic Service	777.46	
Reporting Service	780.58	
Audit Service	60.00	
Editorial Service	650.00	
Insurance	157.51	
Meeting Expense:		
Philadelphia	200.06	
Las Vegas	400.00	
Miscellaneous	20.37	
Bank Charges	4.25	
Total Disbursements		18,002.33
Cash Balance as of June 30, 1958		$ 6,118.76

STATEMENT OF SECURITIES
As of June 30, 1958

1. U. S. Government Savings Bonds:

Number Certificate	Issued Date	Cost	Maturity Value	Cash Value 6/30/58
D682395F	8/29/49	$ 370.00	$ 500.00	$ 443.50
D702345F	12/21/50	370.00	500.00	424.00
M1703542F	12/21/50	740.00	1,000.00	848.00
M1844-J	10/20/52	720.00	1,000.00	812.00
M18346J	10/20/52	720.00	1,000.00	812.00
M18347J	10/20/52	720.00	1,000.00	812.00
M18348J	10/20/52	720.00	1,000.00	812.00
M18349J	10/20/52	720.00	1,000.00	812.00
M18350J	10/20/52	720.00	1,000.00	812.00
M18351J	10/20/52	720.00	1,000.00	812.00
M18352J	10/20/52	720 00	1,000.00	812.00
Totals		$7,240.00	$10,000.00	$8,211.50

Certificate Number	Date Issued	Shares	Value Per Share 6/30/58	Total Value 6/30/68
A. Consumers Power Company:				
G6085	10/ 3/49	28	52⅝	$1,473.50
E157859	12/27/55	1	52⅝	52.62
G164617	1/20/56	1	52⅝	52.63
E191501	3/19/57	2	52⅝	105.25
Total				$1,684.00
B. Central Illinois Light Company:				
B1752	10/ 3/49	6	29½	$ 177.00
B44568	4/19/56	1	29½	29.50
***B55859	3/28/58	7	29½	206.50
Total				$ 413.00
Grand Total				$2,097.00

Summary

1. U. S. Government Savings Bonds	$ 8,211.50
2. Corporate Stocks	2,097.00
Total	$10,308.50

AMERICAN FISHERIES SOCIETY
FINANCIAL REPORT

July 1, 1958 through August 31, 1958

Cash Balance as of July 1, 1958		$ 6,118.76
Receipts:		
Membership Dues:		
a. Active	$ 282.85	
b. Official	280.00	
c. Library	29.95	
d. Life	107.50	
e. Sustaining	none	
Other:		
Sale of Transactions and Special Publications	505.75	
Redeemed U. S. Government Bonds, Nos. M1610061F, M1773328F, M1773329F, M1773330F, and M208433J	4,147.00	
Net Receipts		5,353.05
Total Receipts		$11,471.81
Disbursements:		
Printing Expense	$ 302.58	
Postage	34.38	
Petty Cash	50.00	
Stenographic Services	335.00	
Editorial Service	500.00	
Remington Rand (Kardex System)	683.31	
Office Supplies	7.39	
Dues—Natural Resources Council of America	50.00	
Miscellaneous	16.40	
Total Disbursements		1,979.06
Cash Balance as of August 31, 1958		$ 9,492.75

Report of Librarian

HOWARD A. TANNER

The past year has been a particularly busy one for the office of the Librarian. Both Volumes 85 and 86 were received for sale and distribution. In addition to heavy demand for these two Volumes, it was the decision of the Executive Committee to reduce the price of Volumes 76 through 80 (1946 through 1950) from $5.00 to $2.00. This action was taken to move a considerable inventory of these volumes. It has resulted in a very large increase in demand.

During the period September, 1957 to September 1958, the following sales and distribution of volumes occurred:

182	volumes were sent out of the Librarian's office on request of the Secretary-Treasurer; the monies for these volumes having been paid directly to the Secretary-Treasurer.		
520	volumes with a sales price of		$2.105.75
120	copies of Special Publication No. 1	@ $ .25 ea.	30.05
32	paperbound indexes	@ 1.00 ea.	32.00
2	clothbound indexes	@ 1.50 ea.	3.00
		total	$2,170.80

The total amount of $2,170.80 has been forwarded to the Secretary-Treasurer. In addition, there are accounts outstanding totaling $381.75.

May I point out that the above amounts are more than double the average yearly sales during the last several years.

Very likely by the time this report is read, the overrun of Volume 87 will have reached the Librarian's office and will be available for distribution.

Up until July 1, 1959, Colorado State University provided the Society's Librarian with a part-time assistant. The University notified us that this support would have to be terminated as of July 1, 1958. The Executive Committee of the Society has authorized the expenditure of $50.00 per month for the hiring of a part-time assistant. This amount is presently adequate for handling the duties of Librarian to the Society. However, should we decide to change to a quarterly publication, it will obviously greatly increase the work load in the Librarian's office.

With the exception of a very few volumes, all volumes preceeding Volume 76, 1946, are now out of print and unavailable. The first 35 volumes, Volumes 1 through 35, (1872-1907) have been sent to the J. S. Canner Company of Boston, Massachusetts, where they have been micro-carded. These micro-cards are available to interested persons and institutions. It is the plan of the J. S. Canner Company, working in cooperation with the Society, to place on micro-cards all of the out-of-print volumes.

Our TRANSACTIONS continue to be well housed in a fire-proof building provided by the Colorado State University.

If it is the wish of your Nominating Committee, I am willing to continue to serve you for another year.

Report of Editorial Board

JOHN B. MOYLE

Volume 87 of the TRANSACTIONS has been printed and is in the hands of the members of the Society or will be shortly. It is approximately the same size as the preceding volume and emphasizes principally salmon propagation, reservoir management, and commercial fisheries. There are, however, papers on a variety of other subjects including one on applied psychology and a couple for those who are mathematically inclined.

In addition to thanking the authors, from whom fine cooperation was had, the Associate Editors deserve special commendation. Most of your Associate Editors gave of their time to review critically four or more manuscripts during the year—and some of these were not easy reading.

An attempt has been made to broaden somewhat the spectrum of papers appearing in the TRANSACTIONS so there is something of interest to all of our members. The American Fisheries Society began, as you know, 88 years ago as an association of practical fish culturists and through the years papers in the TRANSACTIONS have reflected the practical problem-solving approach. This is good for us as a "fisheries" organization. But it is necessary to augment the biological engineering approach with the results from more specialized and basic work. The Editorial Board would greatly appreciate having a chance to consider such more specialized papers for the TRANSACTIONS.

Finance Committee Report

MAJORITY REPORT

EDWARD SCHNEBERGER

In 1956 the Auditing Committee called attention to the serious need of clerical and editorial assistance to the Secretary-Treasurer and Editor, respectively, and recommended a special study to determine means of providing this assistance. The Society approved the recommendation at the Toronto meeting (1956) and in addition made $1,000.00 available to the Editor. The special Finance Committee reporting at the 1957 meeting at Las Vegas recommended the following:

1. That for the fiscal year 1957-1958 the Society approve the recommended budget of $5,000.00 as follows:

Editorial assistance	$2,000.00
Secretarial service for Secretary-Treasurer	2,500.00
Incidentals	500.00

2. That this cost be charged to the general fund but in the event of a deficiency in the general fund the Secretary-Treasurer be authorized to transfer a sum sufficient from the permanent fund to cover such deficiency.

3. That the duties and functions of the Auditing Committee be expanded to include an annual review of the financial status of the Society and the Auditing Committee be authorized to present plans designed to increase revenue.

These recommendations were approved and the Auditing and Finance Committee was charged with the responsibility of (1) determining means of increasing the Society income by a raise in dues or by other means, and (2) to determine the advisability and desirability of a Quarterly Journal.

Your committee devoted considerable study to these problems and in addition drafted the assistance of our very able and hard working Secretary-Treasurer "Woody" Seaman. After considerable investigation of various possible solutions it was deemed advisable to take a poll of the members for further data and opinions on these two vital problems. The Executive Committee at the St. Louis meeting in March 1958 approved the Committee's request to submit a questionnaire to the members in order to better determine the desires of the majority. The response from the members is very gratifying, and a progress report on the results of the poll was given in the June Newsletter.

The final tabulation of the replies is as follows:

VOTES FOR DUES AND QUARTERLY

Dues	Votes	For Quarterly	Against Quarterly
$ 2.00	1	1	0
5.00	28	1	27
6.00	7	1	6
6.50	2	0	2
7.00	2	0	2
7.50	32	7	25
8.00	110	18	92
8.50	1	0	1
10.00	452	340	112
12.50	69	57	12
15.00	229	188	41
Left Bank	17	3	14
Life Members	3	1	2
Abstensions	3	.....	.....
Totals	956	617	336

The number of qualified active members at the time of mailing was 1,815 and therefore 52.7 percent of the members responded by returning their ballot. Of the 956 replies received, 750 or 78 percent indicated a willingness to pay $10.00 or more annual dues. In response to the question of a Quarterly Journal, 617 or 64 percent stated they favored the issuance of a Quarterly Journal.

The need for additional revenue to meet current expenses, provide clerical and editorial assistance and support a Quarterly Journal has been covered in previous reports. The exact amounts needed depend on many factors such as current costs and amount of service the Society undertakes to provide to the members. The principal source of income is from the active member dues. It is therefore very pleasing to note the excellent response to dues of $10.00 or more.

On the basis of the results from the poll and recognition of financial needs, the Committee makes the following recommendations:

1. Dues (a) (To take effect in the current fiscal year 1958-1959)

Active members	$ 10.00
Student members (b)	5.00
Foreign members (c)	5.00
Sustaining members	20.00
Library	5.00
Official	40.00
Life (d)	125.00

(a) The stated amounts are minimum fees, but should anyone desire to make a larger contribution the same should not only be accepted but also encouraged. (Remember, dues of a professional society are tax deductible items!)

(b) Students should be encouraged to become active members and should be admitted to membership at a lower rate while students and be entitled to all of the rights and privileges of an active member except to hold an elective office. To qualify, a student would need annual endorsement by an active member in good standing.

(c) Foreign members shall be nonresidents of any American Republic desirous of membership in the Society at a reduced rate. A foreign member shall have all the rights and privileges of an active member except to hold an elective office. A foreign member may hold an active membership upon payment of the active membership fee.

(d) Payable in three annual consecutive payments of $42.00. Failure to submit an annual payment would carry a $5.00 penalty when reinstated.

2. Quarterly Journal.

It is recommended that the Society issue a Quarterly Journal provided that (a) the Executive Committee finds there are sufficient funds available, and (b) the editorial board has the necessary assistance to assure the prompt and regularly scheduled publication of a Quarterly Journal without sacrificing quality or lowering standards.

3. That the Society continue to provide clerical and editorial assistance in keeping with the budget submitted by the Secretary-Treasurer and approved by the Society.

Your committee discussed many things that might be done by the Society to improve service to its members. A complete review of these discussions is not possible but there is one item that should be called to the attention of the Society for further study. It is evident that as the services provided by the Society are expanded, a heavier workload is placed on the Secretary-Treasurer. Therefore, it is possible that in the not too distant future the Society may find it desirable or even necessary to employ a full-time paid Executive Secretary with a permanent office. This is indeed a problem worthy of serious study by future committees.

The Chairman takes this opportunity to express his appreciation of the fine cooperation of his co-members of the Committee. In addition, the Committee as a whole expresses its gratitude to Secretary-Treasurer Seaman for his earnest and sincere efforts.

MINORITY REPORT

RICHARD H. STROUD

Mr. President, fellow Members, I feel compelled to take formal exception to certain aspects of the report of the special Finance Committee of which I am a member, and to submit a supplementary minority report. In doing so I wish to acknowledge the very amicable and constructive attitude of my fellow committee members in our many spirited discussions. I have little doubt that we are unanimous as to ultimate goals for the Society. I disagree rather as to how far the Society should go at this time.

My strong feeling is that the Society membership has had its fill of marking time while the world passes it by. I believe that we are ready NOW to take a giant stride ahead rather than taking a mere baby step. We should decide TODAY to take the bit in our teeth, to make an investment in the future.

Otherwise, as I see it, we may postpone indefinitely gaining the professional stature and the public prestige we all want. We cannot afford to mark time if fishery workers are to meet the social and economic pressures of the day.

You have heard Chairman Schneberger present the results of the membership poll regarding membership dues and publication of a quarterly journal. It is evident that a comfortable majority agree that annual dues must be increased. This reflects a gratifying level of maturity within our ranks.

I believe, however, that the statistics warrant further discussion at this time. I believe that it is the responsibility of THIS committee NOW (rather than some future committees in the uncertain future) to face up to their rather forceful implications.

Permit me to point out that, while 78 percent of the respondents expressed willingness to pay $10 or more annual dues, the specific vote for $10 was 47 percent. At the same time, 298 members or about 31 *percent of*

those responding signified willingness to pay more. In fact, 24 *percent* of all respondents *voted specifically for* $15 *dues* even though the lower dues level, tied to publication of a quarterly, was stressed in the questionnaire!

Furthermore, I regard it as highly significant that of those registering *opposition* to a quarterly (35 percent of the total respondents) over half (19 percent of total respondents) *voted to pay* $10 *or more dues.* Apparently then, a substantial number of members recognize a need for added services apart from publishing a quarterly. At least there was a significant expression of desire along these lines, together with willingness to meet the bill for them.

I submit that your Finance Committee acted too conservatively when it failed to recognize the major issue confronting the Society and to present that issue in clear relief in its questionnaire. It is encouraging to me, therefore, that the members, themselves, sought to clarify the issue. It is equally encouraging to realize that many members recognize and are concerned that strong splinter forces are at work eroding the substance of our Society.

Twice, recently, different Divisions have taken formal resolutions seeking to strengthen professionalism within the American Fisheries Society. Divisional committees have rendered reports on these matters, looking toward generation of national leadership by the parent organization to develop job classifications and eventual professional accreditation of qualified fishery workers.

Are we going to recognize this demand and take forthright action to provide the needed continuing national leadership? Are we, instead, going to repudiate this internal challenge and passively watch the American Fisheries Society wither and decay? I urge that we energetically pursue the first course, and raise Annual Dues for Active Members at least to $15 at this meeting. What will be gained by postponing the significant first step in this direction?

In my opinion, a more forceful presentation of the possible advantages of a $15 dues structure might readily have reversed the actual count as between $10 and $15. I believe the decision rests on what the Society members might realize from the added fee in terms of vital services to fishery workers as a whole. If it's worthwhile, it's salable. I believe it's that simple.

What could be worth $15—less than the price of a daily coke—or whatever additional it takes? I believe that full-time, energetic, imaginative, executive staff leadership is worth that—or whatever more it may require. I believe that the time is ripe to respond to the evident desire of a majority of members to move ahead substantially in the direction of professionalism. We have a long trail to travel, but we must get started before it becomes confused or fades away.

In my opinion, AFS very much requires the services of a *full-time*, paid executive head. Such a man should be young enough to still have dedicated enthusiasm, unbounded energies, and regard it as a challenging career. At the same time, he should be old enough to have had perhaps at least 10 years of varied experience—essentially a professional with some graduate training, recognized in the fishery field, personable, worldly, and mature-minded. I am confident that a number of suitable candidates could be found among our members to provide the energetic program development that so many members obviously envision.

This kind of a man could accomplish much for the membership and the fishery profession. He could provide continuity and cohesion, a rallying point for the Divisions and the National. He could handle the organizational details of meetings. He could contract for editing of the quarterly, if adopted, and ride herd on this and other business matters. He could operate a placement service and work on the vitally important matter of professional classifications and standards, looking toward an accreditation system in the not-too-distant future.

I say the time to act is NOW! Mr. President, I recommend that dues for Active Members be increased to not less than $15 annually to permit employment of an Executive Secretary.

Report of Committee on International Relations

M. C. Jones

Presented by Leslie Scattergood

No report on International Relations in general could be authentic and up-to-date if it were written prior to the issuance of the latest edition of the current day's newspaper. International Relations in fisheries are, in contrast, relatively stabilized, and he who reports them can indulge in some optimism. We believe that questions of territorial waters jurisdiction, such as were fought to a draw at the recent Geneva Conference, are of some interest to this Society. The Geneva meeting was basically an attempt to establish ground rules under which fishing and fish management could proceed. The conference was unable to agree upon a definition of territorial waters because of the conflicting economic interests of the fishing nations. As a result, there is still no universally recognized territorial limit, and friction must arise whenever nations extend their jurisdiction to cover more distant waters. However, except for this one problem, fishery cooperation between countries has been increasingly successful.

To start with verbal activities, there were held in the fiscal year 1958, at least 23 meetings at which international fisheries subjects in one form or another were considered. The locale ranged from Bangkok to Rome and included all the hemispheres. At these meetings, various technical aid programs have been proposed and continued as active working enterprises. As was reported to you in 1955, the governments of Canada and the United States and the United Nations FAO were and are the prime suppliers of scientific and technological fishery knowledge and skills for worldwide consumption. The United States Government assigned 22 persons to 11 foreign countries to provide technical or economic assistance in fisheries, while FAO had more than 30 experts in 20 countries.

An important part of the technical aid program is the training of foreign students and administrators. As a consequence, a growing group of competent workers is able to assume responsibility for projects initiated by foreign technicians.

Canada gives a corresponding amount of attention to Ceylonese trainees that are selected under the Columbo plan.

FAO provides equivalent training to government officials of under-developed countries. Sometimes these men are sent to North American or European countries for further experience and education. Other times, FAO organizes training centres. The Fisheries Division has held a number of these. Two of the most recent were the Training Centre for Fish Processing Technologists at Lima, Peru in 1957, and the Training Centre in Fishery Cooperatives and Administration, at Sydney, Australia, in 1958. Both these training centres were attended by fisheries workers nominated by the governments in the respective regions.

The reports of prior International Relations Committees have listed the several international fishery commissions and organizations, and appraised their value and significance. Similar treatment has been given to the FAO. We will not retrace this path except to mention changes.

The International Pacific Salmon Fisheries Commission has become deeply engrossed in its newly added responsibility—the management of the pink salmon stocks which are of joint interest to Canada and the United States.

The International Commission for the Northwest Atlantic Fisheries was enlarged by the added membership of the Federal Republic of Germany (West Germany) and the U.S.S.R., making the total membership twelve nations. When one observes that this many European and North American nations can harmoniously engage in both research on and management and protection of a group of fishery resources, we have further proof that the fisheries seem to present some subtle medium for international "togetherness."

Another, and relatively recent group, the International Passamaquoddy Fisheries Board, has been formed by the International Joint Commission of the Canadian and United States Governments to study the possible effects on the fisheries of a proposed tidal hydroelectric project. This Board completed two of its scheduled three years of investigation.

During the past year, FAO added several projects to its long list. An International Fishing Gear Congress was held in Hamburg. This was the first time that fishing gear experts from all over the world had met to discuss the many aspects of their business, pool their knowledge, and exchange ideas concerning

their problems and their work. A project of interest to fishery biologists is the publishing of a new periodical "Current Bibliography for Fisheries Science", which requires the reading ing and annotating of more than 500 periodicals from 80 countries.

There are many cases of international cooperation being practiced almost daily without any need for formalized agreements. We will mention a few.

One of the outstanding examples is the work being done in the Pacific Ocean by France, Japan, and the United States. Under the code name EQUAPAC operates an impressive large scale biological and oceanographic survey of most of the tropical Pacific. the job is being done by a rather simple process. Responsible research workers informally decide what should be done, how it should be done, and then pool their resources to do it. When we consider the size of the Pacific, it is obvious that nations must join forces to survey it adequately. Seven Japanese, one French, and four American vessels have taken part in the program.

Another example of informal cooperation involves the exchange of fish eggs between the U. S. and Canada. The federal and state or provincial governments have for the past few years, exchanged the eggs of steelhead, rainbow and cutthroat trouts, kokanee, grayling, and Atlantic salmon. These actions have improved to a considerable degree the sport fishery programs on both sides of the international border.

Still another example is the joint Atlantic herring studies carried on by the Fisheries Research Board of Canada, and the Fish and Wildlife Service in the northwest Atlantic. Close coordination of the programs, particularly vessel operations, has enabled us to progress much more rapidly than would have been possible if the two investigations were conducted independently.

Mr. Beckman, one of our committee members, now in Syria, offers us two suggestions on how American Fisheries Society members can make their own contributions to good international relations. He suggests that when foreign workers or experts in International Organizations request help, it is important that they are promptly answered and assistance given, if possible. When a fishery worker is isolated or in an underdeveloped area, he needs the support of other workers in his particular field. His other suggestion is that North American workers could promote improved international relations by becoming more aware of fishery research being done in other countries and by corresponding with foreign workers in similar fields. So it seems that each of us can play some role in the field of international relations.

Report of Committee on National-State Relations

ALEX J. CALHOUN

Presented by Leo Shapovalov

The committee explored the present tenor of National-State relations as a first step toward possible action by the Society to improve them. We sent questionnaires to each State and Canadian Province, and to the headquarters and regional units of appropriate Federal agencies.

The first two questions were: "Does your organization have serious problems or conflicts over fisheries matters with any Federal (State) agencies? Yes . . . No . . . ." and if 'Yes,' what is the most critical one, in terms of its interfering with attainment of your organization's goals?"

Of the 46 states which replied, 32 said "No" and 14 said "Yes." Details of the "Yes" replies will be discussed later.

None of the regional or headquarters units of the Fish and Wildlife Service, U. S. Corps of Engineers, or Bureau of Reclamation answered the first question "Yes," although some cited less serious problems in reply to another question.

The Bureau of Reclamation expressed no particular difficulty in its relations with the states. It recommended continuing research on fish screens, particularly electric ones, and on rough fish control. It also suggested state support of national legislation to provide wider latitude by the Bureau in handling fisheries problems.

The U. S. Corps of Engineers expressed a desire to work more closely with the states in all stages of project development, particularly planning. Lack of adequate fisheries information, often until plans have already been completed, is a problem for them. They desire earlier provision of data and comments on projects by states, and closer liaison between their district offices and state personnel. Several southeastern states affected by projects of the

Corps of Engineers expressed similar views. Steps have reportedly been taken recently by both sides to resolve their problems.

There was no hint of conflict between the states and the National Park Service or the Forest Service in any of the replies. Forest Service units pointed out many problems which they share with the states and are working on together.

Although the Federal Power Commission was not included in the questionnaire, one state in the Northwest reported serious problems with that agency, based on differences in philosophy and interests. Several states also cited minor problems with the Soil Conservation Service.

The general tone of the National-State relations is apparently quite good at the present time, since three-fourths of the states and all Federal units which replied report no serious conflict. One state chided us gently for placing undue emphasis on this field when things are going so well. Nevertheless, the problems of the 14 states which reported serious conflicts need a closer look.

They fall into two distinct groups. Seven, scattered along the eastern seaboard, have problems with the U. S. Corps of Engineers, primarily over flood control projects. Their most general complaint involves the loss of coastal marsh areas through flood control projects. Drainage of oxbows was also mentioned.

The other seven states center in the Rocky Mountains. They have serious conflicts over large Federal projects with the Bureau of Reclamation or the River Basins sections of the Fish and Wildlife Service, or both.

In general, their complaints were much stronger than those of the Eastern group. They were also aimed much more critically at the Federal agencies involved, and less at the general problems created by the construction projects. In fact, the number and intensity of complaints by the western group is ample proof of an unusually severe conflict between them and the two Federal agencies.

The third question asked was: "Do you have any suggestions for action of any sort which the American Fisheries Society could initiate to improve National-State relations in the fisheries field?"

Only a few of the respondents had suggestions, another indication that relations in general are good. Eight states expressed the hope, in various ways, that the Society might help strengthen the position of fisheries resources in relation to the planning or operation of flood control or reclamation projects. Active support of appropriate legislation, such as amendments to strengthen the Coordination Act, and joining of efforts with other conservation groups with similar objectives, were both suggested.

Two states thought that the Society should bring to the attention of the Fish and Wildlife Service the most urgent fisheries problems of the various states and should encourage the Service to establish research programs along those lines.

A Fish and Wildlife region indicated that the Society's journal, its regional meetings, and its Newsletter were all contributing to better relations with the states.

An interesting thread running through the Forest Service replies suggested that the Society could help the cause of conservation by calling attention to the need for better land management as a basis for healthy inland fisheries resources.

The final item read as follows: "We will welcome descriptions of any more fisheries problems in the field of National-State relations which you want to report. Please rank them in order of importance."

Thirteen replies, well scattered among states and the regional units of the U. S. Fish and Wildlife Service and the U. S. Forest Service, mentioned that poor definition of state and federal areas of responsibility in fisheries and related fields, or poor integration of related programs is a pressing problem needing attention. Quite a few of the 13 expressed or implied a hope that the Society might take a position of leadership in solving it. Encouragement and organization of regional conferences to clarify these problems was suggested as an approach by one respondent.

Other than the above, there was no apparent pattern to the replies concerning less critical problems. The others were too specific for inclusion in this report.

Only eight of the 15 Canadian units responded, and some replies were noncommital. Canadian fisheries are under Federal control, although some provinces desiring it have been given authority over their sport fisheries.

Canada appears to share the United States' diffcult problems centering around cloudy definition of state and federal responsibility, with the added difficulty of cloudy definition of authority in some areas. These were the main sources of conflict in the Canadian replies.

In conclusion, the two major problems revealed by the survey involve fisheries and federal construction projects, on the one hand, and cloudy definition of state and federal responsibilities, on the other.

Vigorous support of federal legislation by the Society, to strengthen the position of fisheries in relation to conflicting interests involved in federal projects, is recommended as a way to help solve this problem.

Perhaps this survey will encourage the federal agencies to re-evaluate their relationships with the states in the two trouble areas. Apparently, they are less ideal than they think, especially in the west.

The possibility that the Society might spark a drive to clarify fields of responsibility between state and federal fisheries agencies is intriguing. This could ultimately lead to greatly increased efficiency. We recommend exploring this possibility.

Report of Committee on Names of Fishes

Reeve M. Bailey

The Committee on Names of Fishes is charged with the responsibility for establishing and maintaining a check list of common and scientific names of fishes, with the objective of achieving uniformity and avoiding confusion in nomenclature. Since publication of its first list in 1948 the Committee has recognized that piecemeal or year-to-year corrections to the list are not a satisfactory method of achieving this objective. Rather, periodic revision with republication is necessary. The first list is now in part outmoded by changes in scientific nomenclature, by the need for realistic modification and reappraisal of some previously adopted common names, and, in particular, by the demonstrated need for increased coverage of the list. With the approval of the Society, the Committee began active revision of the list two years ago.

Revision has entailed certain changes of format from the first list. All fishes are to be assembled in family groups, each designated by scientific and common name. Authorities for scientific names, omitted from the earlier edition, are included. Instead of listing an individual entry number for each species, these are omitted and indexing is by page references. As in the first edition there are indices to scientific names, both by genera and species, and to common names, including not only names accepted but also familiar names that are rejected. The coverage has been increased from 570 better-known species to include all freshwater species of the United States and Canada and marine species occurring on or above the adjacent continental shelves. Deep-water fishes are generally excluded as are also those of the West Indies and Hawaiian Islands. For poorly understood groups, especially the smaller fishes of the Alaskan coast and the rich Caribbean fauna of southern Florida, some species are of necessity omitted from this revision. These forms may be added in future revisions as they become better known and of greater human interest.

The Committee discovered that much time is required to achieve a meeting of seven minds on both common and scientific names of nearly 2,000 species. The geographic spread of the Committee members, a necessary arrangement in order to insure adequate representation of the many faunal areas involved, complicated the job of working out mutually acceptable name selections. Two weeks ago at the meeting of the American Institute of Biological Sciences it was possible for five Committee members to meet together for several prolonged sessions. This resulted in unified approval on all or practically all of the freshwater fishes and on a large part of the marine species. Working plans were developed for the prompt completion of the remaining groups and we are confident that a completed list will be realized by late fall. At that time we propose to mimeograph the list and place copies in the hands of those workers and groups of workers who have shown most interest in the activities and objectives of the Committee. Criticism and suggestions pertaining to omissions, errors, and unhappy name selections will be enlisted. Such suggestions will be considered and integrated with the list and a corrected list should be ready early in the spring. The second list should be placed in all members' hands prior to the 1959 meeting. At the meeting of the Executive Committee last night it was decided to issue the

revised list of common and scientific names as Special Publication No. 2 of the AFS, in an edition of 4,000 copies. The Committee was charged with responsibility of publishing the list promptly.

Report of Committee on Water Pollution

CLARENCE M. TARZWELL

When the Pollution Committee of the American Fisheries Society became a permanent committee it was decided to embark upon a rather ambitious program which has as its aim a continuing survey of pollution control activities and research in water pollution throughout North America. The initial plan was to make a survey of the entire area every three years and to cover about one-third of the area each year.

Questionnaires were sent out to all control agencies and all agencies or groups engaged in research on water pollution and its effects on aquatic life. Each of the agencies or groups contacted was requested to supply information covering a three year period.

This program got under way in 1955 and the first reports were received that year. The work continued through 1956 and 1957 at which time the initial survey was completed.

Your present Committee has assembled the data from the supplementary reports for each of these years, has combined and reproduced them so that the information might be made available to members of the Society and all cooperating agencies and organizations. It was felt that if these groups are to continue to furnish data they should at least receive reports of the information so collected.

Further, it was believed that the receipt of these reports would make them more amenable to filling out questionnaires in the future.

Therefore, we delayed the sending out of questionnaires this year until the reports for the last three years could be assembled, reproduced and furnished to each of the committee members.

An examination of this assembled report indicates that coverage of part of the area each year for three years results in a poorly organized report which is difficult to interpret. Further, since the cooperating agencies and groups were asked to report on the past three year-period, the period covered encompasses a span of at least five years. This renders the data somewhat uncomparable. Further, as all agencies in each of the states were not covered in the same year, the result has been that data on a given state or federal agency may appear in three to five different places and it is not easy to gain an over-all understanding of the programs. Therefore, it was decided that an attempt would be made to cover the whole area with the addition of Mexico, which has not been covered heretofore; in a period of one year. It is hoped that this approach will result in a better organized and more understandable report.

Study of the combined reports for the past three years indicates that data was not secured from the control agencies of the States of Arizona, Minnesota, Illinois, Vermont, Connecticut, and Maryland. Data was secured from 42 states and seven provinces of Canada, but four of the states (Texas, Oklahoma, Maine, and Nebraska) did not list pollutants in their order of importance. Data was secured from 38 states indicating the importance of the various kinds of pollutants. The various pollutants listed in their relative order of importance were as follows: (1) sanitary sewage, (2) textile processing wastes, (3) pulp and papermill wastes, (4) plating wastes, (5) mining wastes, (6) oil and oil refinery wastes, (7) wastes from the production of chemicals, (8) general food processing wastes, (9) metal processing wastes, (10) milk processing wastes, (11) tannery wastes. The reports of each of the states and provinces were tabulated, each type of waste being assigned its relative importance as given by the control agencies. These ratings were then added and the total divided by the number of reporting states or provinces, to secure an average rating. The ratings for each were as follows: sanitary sewage 1.9; textile processing wastes 2.5; pulp and papermill wastes 2.6; plating wastes 2.67; mining wastes 2.8; oil and oil refinery wastes 2.9; chemical wastes 2.94; general food processing wastes 3.47; meat processing wastes 3.5; milk processing wastes 3.57; and tannery wastes 4.4.

Sanitary sewage was listed as a problem in 31 states and five provinces. It was designated as the most important problem in 17 states and two provinces and ranked number two in four states and two provinces. There were only seven states in which it was not listed as an important pollutant. Textile processing

wastes were reported as being of importance in eight states. They were not listed as first in any state but were listed as being second in importance in six states. Pulp and paper-mill wastes were reported as a problem in 19 states and four provinces. In five states and one province they were considered to be the number one problem, and in six states and one province the number two problem. Plating wastes were considered to be important in eight states and one province and were reported as being the most important pollutant in four states. No state considered them as the number two problem. Mining wastes were listed by 16 states and four provinces. Four states and one province designated these wastes as being the most important, and six other states considered them to be the number two problem. Oil and oil refinery wastes were a problem in 18 states and five provinces. They constitute the number one pollutant in three states and three provinces, and were considered the number two waste in three states and two provinces. Wastes from the chemical industry, especially the synthetic chemicals, are increasing in importance. They were listed as an important pollutant by 17 states and one province. They were considered to be the most troublesome problem in four states, while four other states considered them second in importance. General food processing wastes are important in 15 states, although they are considered the number two pollutant in three states, but their general importance was indicated by the fact that they were considered to be the number five problem in four states. Metal processing wastes other than plating wastes were stated as being important in five states and one province. These wastes were not considered to be of major importance as they were not ranked first in importance and were ranked second in only one state and one province. Milk processing wastes constituted problems in 14 states. These wastes were considered to be of number one importance in New York, and were rated number two in four states, one of them being Wisconsin. Tannery wastes were considered to be pollutant in five states but they were of rather minor importance as they were not the number one or number two problem in any of the states or provinces.

Distillery, citrus packing, lumbering, naval stores and radioactive wastes were each listed once by a different state as was siltation.

The research reports received indicated that research on the effects of water pollution on aquatic life is being carried out in 31 states. Fifteen states indicated that they were not carrying on any research in this field. Bioassay investigations are being carried on in 15 states. It is very evident that the use of bioassays for determination of toxicity of various waste materials to fishes has increased rapidly during the past few years.

Among seven Canadian Provinces reporting, five stated that they were carrying on research and two reported no research in progress. Bioassays studies are being carried out by one province.

The situation regarding personnel for enforcement agencies in the states and provinces was as follows: Three reported having no personnel, and 10 reported having a decrease in staff. The staff remained the same in 24 areas, while 19 reported an increase in staff. This date indicated an over-all increase in staff in the pollution control agencies. The report also indicates that progress is being made in both the enforcement agencies and research activities. It is hoped that this trend will continue in 1958 and that the report for the present year will show even greater increases.

As you know, a job of this kind is a co-operative effort, not only on the part of the committee members to whom I wish to express appreciation at this time for their diligent efforts, but also co-operating agents who are asked to fill out the form.

If you have not already done so, we would ask you to please co-operate in giving us the best answer possible to these forms, and I also wish to solicit your kind co-operation in the future.

Registered Attendance Eighty-Eighth Annual Meeting

Adams, Charles, Arkansas
Albright, Gus, Arkansas
Aldrich, A. D., Florida
Allen, J. Frances, Washington, D. C.
Allen, Walter M., Montana
Allen, William J., Arkansas
Allison, Leonard N., Michigan
Amory, H. G., New Jersey
Anderson, Bertil G., Pennsylvania
Andriano, Don, Utah
Antolosky, Paul, Pennsylvania
Arnold, Edgar L., Jr., Texas
Ashley, James F., Massachusetts
Bailey, Edward W., Massachusetts
Bailey, James R., Missouri
Bailey, Reeve M., Michigan
Balderston, Edward T., Pennsylvania
Baldwin, Norman, Michigan
Ball, Robert C., Michigan
Balzer, George C., Jr., Massachusetts
Barnes, William B., Indiana
Barry, E. M., Maryland
Beall, Harvey, West Virginia
Bennett, Vernon, Missouri
Bentley, Wm. G., New York
Berry, Joan, Mississippi
Berry, Richard, Rhode Island
Berry, Rod, Mississippi
Beyerle, George B., Pennsylvania
Bielo, Robert, Pennsylvania
Biggs, John, Washington
Bitzer, Ralph R., Massachusetts
Blakey, Harold L., Washington, D. C.
Boccardy, Joseph A., Pennsylvania
Bogart, Maynard M., Pennsylvania
Bond, Lyndon H., Maine
Bouldin, R. W., Tennessee
Bowers, Charles C., Kentucky
Bradford, Arthur D., Pennsylvania
Branson, Dillard M., Missouri
Bridges, Colton H., Pennsylvania
Briggs, Philip, New Jersey
Britton, W. W., Pennsylvania
Bucknam, George W., Maine
Burch, Clarence, Oklahoma
Burdick, G. E., New York
Burns, Lentho, New Jersey
Burris, Wm. E., Texas
Burwell, Robert W., Minnesota
Busnardo, Marco S., New Jersey
Buss, Keen, Pennsylvania
Byrd, I. B., Alabama
Callaway, Ben, New Jersey
Callison, Charles H., Washington, D. C.
Campbell, D. Wayne E., Pennsylvania
Campbell, Bob, Missouri
Carbine, W. F., Michigan
Carlander, Kenneth D., Iowa
Carter, Bernie, Kentucky
Cash, Ben, Missouri
Chapoton, Robert B., North Carolina
Chin, Edward, Texas
Chuba, Joseph V., New Jersey
Clark, Clarence F., Ohio
Clark, Minor, Kentucky
Clay, William M., Kentucky
Clugston, James, Pennsylvania
Cobb, Roland H., Maine
Coffin, William P., New Jersey
Cook, Viola H., Virginia
Cooper, Edwin L., Pennsylvania
Cooper, Gerald P., Michigan
Cooper, Helen, Missouri
Corl, Kenneth G., Pennsylvania
Cornell, J. H., North Carolina
Cottam, Clarence, Texas
Cox, Nelson, Arkansas
Cramer, Wilbur, Pennsylvania
Critchfield, J. M., Pennsylvania
Croft, Donald L., Pennsylvania
Cronan, John M., Rhode Island
Curtis, Cy, Oklahoma
Davis, Wm. S., North Carolina
Day, Albert M., Oregon
Dean, Wallace, Pennsylvania
De Boer, M. J., Michigan
Denmead, Talbott, Maryland
Dequine, Jack, Florida
De Sylva, Donald P., Delaware
Dickie, Lloyd M., New Brunswick
Dickson, Arthur W., North Carolina
Dickson, Fred J., Georgia
Dingle, T. J., Pennsylvania
Dolan, Thomas, Pennsylvania
Domogalla, B., Wisconsin
Donaldson, Lauren R., Washington
Donley, Benjamin F., New Jersey
Douglass, E. J., Virginia
Duck, Lester G., Pennsylvania
Eddy, Gerald E., Michigan
Ehlinger, Neil, New York
Eicher, George, Oregon

Eicholtz, J. P., Pennsylvania
Eipper, A. W., New York
Elkins, W. A., Minnesota
Elser, Harold J., Maryland
Erickson, Jack, Ohio
Eschmeyer, Paul, Michigan
Essbach, Alban R., New Jersey
Everhart, Harry, Maine
Everim, W. J., Montana
Faber, Lester F., Iowa
Fasching, Edward J., Pennsylvania
Ferguson, R. C., Ontario
Fielding, James R., Georgia
Filkosky, Peter J., Pennsylvania
Fischler, Ken, North Carolina
Fleener, George, Missouri
Foote, Leonard E., Georgia
Foster, Charles R., Washington
Foster, George M., Iowa
Foster, Glen R., Nebraska
Fox, Howard, Pennsylvania
Forney, John L., New York
Fukano, Kiyoski G., Michigan
Gale, Larry R., Missouri
Galligan, James P., Connecticut
Garlick, Lewis R., New Mexico
Gascoyne, D. R., Massachusetts
Gasper, Don, West Virginia
Gatlin, John, New Mexico
Geesaman, Earl E., Pennsylvania
Gentry, Glenn, Tennessee
George, Lee, Pennsylvania
Gerking, Shelby D., Indiana
Gibree, Norman, Massachusetts
Gill, Esther, Pennsylvania
Gingrich, J. E., Pennsylvania
Golden, M. J., Pennsylvania
Goldman, Elliot J., Pennsylvania
Gordon, Seth, California
Gottschalk, John S., Virginia
Grassl, E. F., New York
Greeley, John R., New York
Green, Don, Nebraska
Grenoble, John W., Pennsylvania
Gresh, Walter A., Georgia
Gross, Richard, New Jersey
Grosslein, Marvin D., New York
Groves, Frank W., Nevada
Gutermuth, C. R., Washington, D. C.
Hamer, Paul E., New Jersey
Hamilton, H. G., Nebraska
Hanson, George, West Virginia
Harkness, W. J. K., Ontario
Harmic, Jay, Delaware
Haskell, David C., New York
Hassler, William W., North Carolina
Hatch, Richard W., New York
Havey, Kieth A., Maine
Hayford, Charles, New Jersey
Hayford, Robert, New Jersey
Hazzard, Albert, Pennsylvania
Heffelfinger, Rollin, Pennsylvania
Heinen, E. T., Florida
Hendershott, R. L., Florida
Henderson, Croswell, Ohio
Hess, Charles F., Pennsylvania
Heyl, Dan, Pennsylvania
Hile, Ralph, Michigan
Horrocks, Amos W., New Jersey
Horton, Donald B., Rhode Island
Huckins, Robert K., New Jersey
Hudoba, Michael, Washington, D. C.
Huet, Marcel, Belgium
Hulsay, Andrew H., Arkansas
Hunn, Joseph B., Maryland
Hunter, R. P., Connecticut
Idyll, C. P., Florida
Jackson, Charles, Washington, D. C.
Jackson, Daniel F., Michigan
Jackson, Roy I., British Columbia
Jacob, Buddy L., Pennsylvania
Janzen, Daniel H., Washington, D. C.
Jenkins, Robert M., Washington, D. C.
Johnson, R. E., Virginia
Johnson, W. L., Washington, D. C.
Jones, Francis L., New Jersey
Joslin, Verne E., Minnesota
June, Fred C., North Carolina
Karnasut, Prida, Thailand
Karper, Thomas B., Pennsylvania
Kimball, Thomas L., Colorado
King, Willis, Washington, D. C.
Kinney, Edw. C., West Virginia
Kuester, Donald, Missouri
Lachner, Ernest A., Washington, D. C.
Lagler, Karl F., Michigan
Lamb, George R., Pennsylvania
Lambou, Victor W., Louisiana
Lane, Richard A., Pennsylvania
Larsen, Alfred, Pennsylvania
Latimer, R. E., Pennsylvania
Lawrence, W. Mason, New York
Laythe, Leo L., Oregon
Lennon, Robt. E., West Virginia
Leonard, Justin W., Michigan
Leonard, Ross, Idaho
Lepore, Armand, New Jersey
Lillie, Merrill, Pennsylvania
Lockett, William J., Pennsylvania
Loftus, Ken, Ontario
Lund, Wm. A., New York
Luttringer, Leo A., Pennsylvania
McArthur, C. B., Mississippi
McBroom, James T., Washington, D. C.

McCreary, Ray, Pennsylvania
McCrimmon, H. R., Ontario
McCusker, Don, G. L. F., New York
McFadden, James T., Pennsylvania
McHugh, J. L., Virginia
McKernan, Donald L., Virginia
McNally, Anne, Pennsylvania
McPeek, D. S., Pennsylvania
Mac Kay, H. H., Ontario
Madden, K. M., Iowa
Margargel, George, Pennsylvania
Mair, W. W., Ontario
Malcom, Jess W., New Jersey
Mansueti, Romeo J., Maryland
Martin, N. V., Ontario
Massmann, William H., Virginia
Mathis, William P., Arkansas
Meigs, Robert C., Washington
Meyers, Caldwell D., Illinois
Micco, Joseph J., Pennsylvania
Miller, Jack G., Pennsylvania
Mihursky, J. A., Pennsylvania
Moffett, James W., Michigan
Montgomery, Alex, New Jersey
Moorhead, Helen L., Pennsylvania
Moyle, John B., Minnesota
Mullan, James W., Massachusetts
Muncy, Robert J., Maryland
Murawski, Walter S., New Jersey
O'Brien, Paul F., Pennsylvania
O'Connor, Joel S., Rhode Island
Ogden, John S., Pennsylvania
Otis, James C., Jr., Massachusetts
Pacheco, Anthony L., Virginia
Palmer, Glenn, Illinois
Patton, Fred, New Mexico
Paul, Bob, Washington, D. C.
Pautzke, Clarence F., Washington
Pelletier, Richmond, Quebec
Phillips, Arthur M. Jr., New York
Phipps, Frank, Kentucky
Pickering, Quentin H., Ohio
Pickup, John, New York
Piper, Robert G., West Virginia
Pippin, Dru L., Missouri
Plosila, Daniel S., Maryland
Pongsuwana, Umpol, Thailand
Prevost, Gustave, Quebec
Probst, Robert T., Pennsylvania
Pyle, Horace A., Pennsylvania
Quick, Paul T., Washington, D. C.
Raney, Edward C., New York
Reddecliff, Jack M., Pennsylvania
Regier, Henry, New York
Reintjes, John W., North Carolina
Ricker, Wm. E., British Columbia
Riethmiller, Ray H., Ohio
Riggs, Carl O., Oklahoma
Robinson, David W., West Virginia
Robbins, Otis, Jr., Pennsylvania
Roelofs, Gene, Michigan
Rooker, William T., Washington, D. C.
Rounsefell, George A., Texas
Roussow, George, Quebec
Ruhr, Gene, Tennessee
Russack, John, New Jersey
Rutherford, R. M., Washington, D. C.
Saanin, H., Indonesia
Sabine, John, New York
Saila, Saul B., Rhode Island
Saksena, Vishnu, Maryland
Scattergood, L. W., Maine
Schaefer, M. B., California
Schafer, Harry, Louisiana
Schneberger, Edward, Wisconsin
Schneider, P. W., Oregon
Schultz, Leonard P., Washington, D. C.
Seaman, Woody, Virginia
Scott, Royall, Maine
Secoy, Les., Pennsylvania
Sedam, John B., Pennsylvania
Seeland, Frank, New York
Selke, George, Minnesota
Seyberth, Leonard J., Wisconsin
Seymour, Allyn, Washington, D. C.
Shapovalov, Leo, California
Shaw, Sam, Pennsylvania
Sheesley, Dorothy E., Pennsylvania
Shell, E. Wayne, New York
Shoemaker, Carl D., Washington, D. C.
Shurr, Leo F., New Jersey
Siegler, Hilbert R., New Hampshire
Simes, J. Curtis, Pennsylvania
Sindermann, Carl, Maine
Slastenenko, E. P., Ontario
Smith, Austin D., Delaware
Smith, David J., Maryland
Smith, Lloyd L., Jr., Minnesota
Smith, Roland F., New Jersey
Smith, Stanford H., Michigan
Sneed, Kermit E., Oklahoma
Snieszko, S. F., West Virginia
Sorenson, Dewey, Pennsylvania
Southwell, Don, Florida
Speaker, E. B., Iowa
Sprecher, George E., Wisconsin
Stackhouse, H. R., Pennsylvania
Steen, M. O., Nebraska
Stevens, Richard I., New York
Stevenson, James, Arkansas
Stringer, Hulon, Tennessee
Stroud, Dick H., Washington, D. C.

Studholme, Allan T., Massachusetts
Sturgis, Howard O., Washington, D. C.
Sullivan, John, Pennsylvania
Suomela, Arnie J., Washington, D. C.
Surber, E. W., Georgia
Svenson, Knut M., New York
Swartz, Albert H., Massachusetts
Swenson, H. O., Minnesota
Swingle, H. S., Alabama
Tack, Peter, Michigan
Tarzwell, Clarence M., Ohio
Taub, Stephen H., New York
Taylor, William R., Washington, D. C.
Tennant, Donald L., Pennsylvania
Thomas, Colin, Pennsylvania
Thomas, Jim, New Jersey
Thompson, Fred A., New Mexico
Thompson, Paul E., Washington, D. C.
Thompson, William F., Washington
Titus, Harold, New York
Tompkins, Bill, Massachusetts
Toole, Marion, Texas
Toth, Robert J., Massachusetts
Totman, Washington, D. C.
Towell, William E., Missouri
Trembley, F. J., Pennsylvania
Trembley, Gordon L., Pennsylvania
Tresselt, Ernest F., Maryland
Troisi, Robert T., New Jersey
Tulenko, Paul Q., Missouri
Tunison, A. V., Washington, D. C.
Twichell, Reed, Missouri
Underhill, A. H., New Jersey
Van Oosten, John, Michigan
Van Winkle, J. H., Oregon
Vincent, Robert, New York
Voigt, William Jr., Pennsylvania
Wade, Gerry, Maine
Wahl, Richard, West Virginia
Walburg, Charles H., North Carolina
Walker, Charles R., Missouri
Webster, Dwight, New York
Wells, Ray M., Missouri
Werner, W. H. R., Ontario
Westerveld, Garret, New Jersey
Whitney, Richard R., Maryland
Wilbert, Albert, New Jersey
Wilder, Norman, Delaware
Wilkins, L. P., Tennessee
Williams, Charles E., Pennsylvania
Wisby, Warren J., Wisconsin
Witt, Arthur, Jr., Missouri
Witt, Miles D., Pennsylvania
Wood, James W., Oregon
Wopart, J. J., Pennsylvania
Wright, James E., Jr., Pennsylvania
Wright, Stillman, Maryland
Wuenschel, Ott, Pennsylvania
Wurtz, Charles B., Pennsylvania
Yamanaka, Ichiro, California
Younger, Roy R., New Jersey
Zamos, James A., New Jersey
Zettle, J. L., Pennsylvania
Zurbuch, Pete, West Virginia

IN MEMORIAM - 1958

L. M. Bickett, California
Stanley Bright, Pennsylvania
Dr. H. S. Davis, Florida
Dr. R. B. Miller, Alberta
Harry B. Shaffer, Massachusetts
William Timson, California